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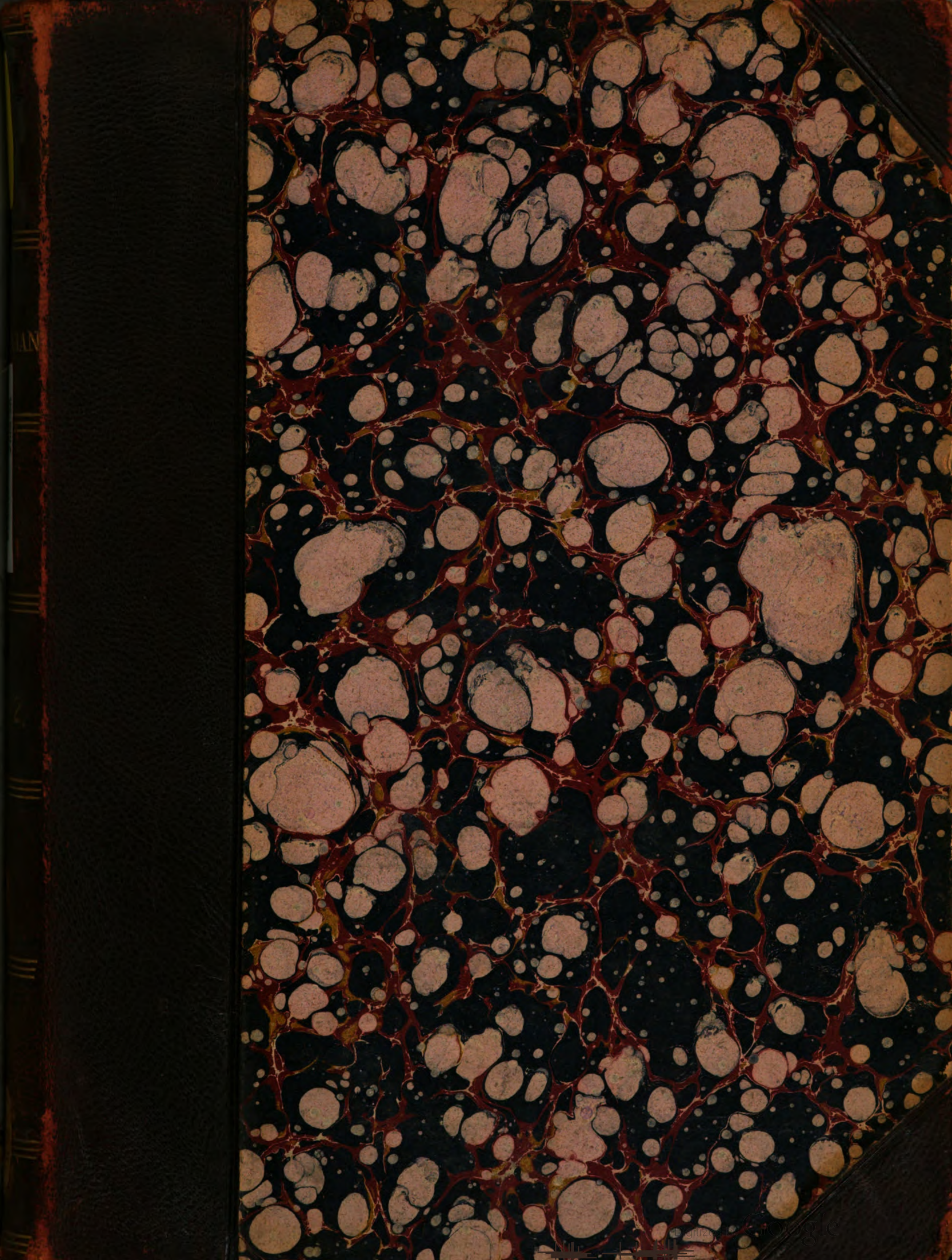

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THE ELECTRICIAN:

A WEEKLY JOURNAL OF

THEORETICAL AND APPLIED ELECTRICITY AND CHEMICAL PHYSICS.

No. 1.—Vol. VIII. SATURDAY, NOVEMBER 19, 1881. Price 4d.

SLIP

Electric Light in Theatres.—The theatre of Lafayette at Rouen is lighted by means of Siemens lamps.

Electric Railway at Wiesbaden.—The construction of the electric railway between Wiesbaden and Neroberg has been begun.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended October 28 amounted to £3,321.

The Telephone in Hong Kong.—A license has been granted to the Oriental Telephone Company to introduce the telephone into Hong Kong.

New Telephone Company in Canada.—The Quebec and Levis Telephone Company has published its prospectus, and expects to commence operations at once.

On the "Spree."—An interesting trial will shortly be made on the "Spree" of a method of employing electricity instead of steam for tugging sailing vessels.

Electric Light at Barnsley.—It is stated that the Town Council have decided to light the streets with the electric light for eight nights as an experiment.

The Telephone in Russia.—The Russian Government has appointed a commission to make experiments on the practical utility of the telephone for military operations.

The Brush Light in Canada.—It is stated that the Brush Electric Light Company are about to establish a manufactory in Canada, probably at Toronto or Montreal.

Royal Society.—On Thursday last a paper "On the Production of Transient Electric Currents in Iron and Steel Conductors," was read before this society by Professor Ewing.

New Company.—The American Electric Railway and Power Company filed articles of association on the 24th of October, capital 10,000,000 dollars. The principal office will be in New York.

The Rating of Telegraph Wires.—The Finance Committee of the St. James's Vestry have been instructed to report on the liability of telegraphic wires to be rated under the Telegraph Act, 1868, Section 22.

Electric Light for Lighthouses.—It is said that Congress is to be asked to vote 50,000 dollars to introduce the electric light into several lighthouses on the American coast, which are at present without it.

Society of Telegraph Engineers and of Electricians.—Next Thursday the paper will be, "A Report upon the International Exhibition of Electricity in Paris," by Sir C. T. Bright and Professor Hughes.

Electric Light for Aberdeen.—The Town Council of Aberdeen have, after much discussion, decided to give notice that they intend to apply to Parliament in the ensuing Session for powers to introduce the electric light into the town.

Electric Light in Greece.—It is reported that the electric light is to be introduced shortly into Athens. The bay of Phalera has been lighted during the summer by means of twenty Jablochkoff lights, and this number is to be increased.

Exports.—According to the Board of Trade returns for October the values of the exports of telegraphic wire and apparatus for that month were as follow:—In the three years 1879, 1880, and 1881, viz., £412,201, £64,030, £115,167.

London Platino Brazilian Telegraph Company.—The revenue of this company for the month of August, 1881, is estimated at £1,783 (Western and Brazilian portion £1,119, Land Lines £664), as against £1,746 for the corresponding period of last year.

Telegraphic Communication between France and Spain.—We understand that a commission of French and Spanish telegraph officials have held meetings in Madrid to consider the best means for facilitating telegraphic communication between the two countries.

The Eastern Telegraph Company's Cables.—We understand that this Company's vessel the "Retriever" has repaired two of the faults, and the "John Pender" has repaired one fault of those caused by the violent storm as mentioned by us a short time since.

Electric Railway in Paris.—It is stated that the municipal council are very pleased with the electric railway, and that they are thinking of trying the experiment of an elevated railway in some parts of Paris, the motive power for which shall be supplied by electricity.

Appointment.—We learn that Mr. Samuel Vyle, A.S.T.E. and E., Inspector of Government Telegraphs for the Middlesbro' district, has been appointed Superintendent Electrician to Messrs. Hammond and Co., the concessionaires of the Brush light in the North of England.

Electric Lighting at Berlin.—It is stated that the question of electric lighting for Berlin is at present in abey-

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ance, pending the report of a municipal commission, who have been appointed to visit London and Paris and make observations on the methods in vogue in these two cities.

THE ELECTRIC LIGHT FOR IRONWORKS.—It is stated as probable that the electric light will be introduced into the Swinton Ironworks, near Sheffield, which have recently been restarted. The telephone is also to be used to connect the works with Car House and Aldwarke Main collieries.

THE TELEPHONE AND CONTACTS.—M. Emile Lacoine, of Constantinople, writes to *L'Electricien* for November stating that the telephone can be used to advantage to determine the exact value of electrical contacts, particularly in clocks. By this means any irregularity in the system can be detected and rectified.

TENDERS FOR ELECTRIC LIGHTING.—The Sevenoaks Local Board are inviting tenders for lighting by electricity. A station will be provided on terms to be agreed upon. Further particulars can be obtained on application to the Clerk of the Local Board, Sevenoaks, Kent. Tenders must be sent in by the 10th December.

THE ELECTRIC LIGHT IN HOTELS.—With reference to a note in our issue of the 5th inst., in which we stated that Swan's incandescent light had been introduced into the Corporation Hotel, Middlesbrough, a correspondent informs us that Mr. Lamb, of Dundee, has employed the light in his hotel for the last five months.

ELECTRIC LIGHT IN AQUARIUMS.—The electric light has been introduced into the laboratory of marine zoology recently established at Banyuls-sur-Mer in the Eastern Pyrenees. The steam engine which pumps the sea water into the aquariums will be used as a generator. The light will be used to study marine life, and will, we believe, be submerged in the tanks.

ST. MARTIN'S VESTRY.—It will be noticed that this vestry is inviting tenders for the installation of the electric light in the district. The sites under the control of this authority are some of the best in the world for the display of the capabilities of the electric light. The various engineers will have to prepare their own plans and submit their suggestions to the board. We shall again refer to this proposed work.

THE TELEGRAPH IN RUSSIA.—It is stated that the merchants and bankers of Odessa are about to memorialise the Government to permit messages to be delivered per the Indo-European line, which passes through the town, as well as by the Government lines. It appears that when these latter are broken down business men are deprived of the service of the telegraph, although the Indo-European line may be working all right.

ELECTRIC COMMUNICATION WITH LIGHTHOUSES.—The proposal recently brought prominently forward in London for the connection of lighthouses and lightships with the shore by means of telegraph cables has been adopted for some time in Canada. The cable connecting Bird Rock Lighthouse, in the Gulf of St. Lawrence, with the mainland, recently broke, but was speedily repaired by the ss. "Newfield."—*Colonies and India.*

THE TELEPHONE IN BERLIN.—We hear that it has been determined to establish telephone rooms in a certain number of the post offices of Berlin. Each telephone room will be divided into small compartments with space for one person, and these compartments will be specially constructed to deaden the voices of other persons in the same room. *La Lumière Electrique* says that similar arrangements have been adopted at Hamburg with good results.

LEGAL.—It is reported from America that Mr. George H Christy, representing the Brush Electric Company, of Cleveland, has brought suit in the United States Circuit Court against the Siemens-Anderson Steel Company for an infringement of plaintiff's right. It is claimed that the infringement consists in using the Weston and Fuller lamps, which are constructed on the same principle as the Brush, the right to use copper-coated carbons being involved in this suit.

"THE OPERATOR."—Our New York contemporary, the *Operator*, has issued a special number for the 1st November, which consists of thirty-six pages. It says much for the interest taken in telegraphic matters in the United States that our contemporary should be in a position to print and publish such a number, and we congratulate the *Operator* on its enterprise. Our opinions do not always accord with those of our contemporary, but we wish it all prosperity nevertheless.

CLEVELAND INSTITUTION OF ENGINEERS.—The opening meeting of this institution was held on the 7th November, at Middlesbro'. Electrical subjects came prominently before the meeting, for we notice that, in addition to a paper by Mr. S. Vyle, on "A New Form of Lightning Conductor and Method of Testing," the electric light question was discussed with interest. In the course of the discussion Mr. Carter, of the Corporation Hotel, whom we noticed in our issue of the 5th of November as having introduced the Swan lamp into his hotel, spoke in high terms of its efficiency.

AN INTERNATIONAL EXHIBITION AT ROME.—A project has been set on foot for holding a universal exhibition in Rome in 1885-86. Committees have already been formed in various large towns, such as Liverpool, Manchester, Birmingham, &c., and a central committee in London, with the Lord Mayor of London at its head, to obtain the co-operation of British manufacturers. If the various applications of electricity make as rapid strides towards perfection in the period that will elapse before this exhibition will be held as they have done in the past few years, they should occupy a very prominent position at Rome in 1885-86.

WERDERMANN V. THE SOCIETE GENERALE D'ELECTRICITE.—This was an appeal before the Master of the Rolls and Lords Justices Lush and Lindley, from the overruling by Vice-Chancellor Bacon of the defendant company's demurrer to the plaintiff's statement of claim (see *Electrician*, Vol. VII., No. 3, p. 39). The case turned on the purely legal question as to whether since the Judicature Act an objection to an action for want of parties can be taken as it could in the late Court of Chancery by a demurrer. Their lordships were unanimously of opinion that it could not, and that the whole practice of demurring for want of parties was now at an end.

CHEAP TELEGRAPHY.—A correspondent doubts a recent statement of Mr. Fawcett's that a reduction in telegraph rates would result in a loss of £200,000 a year for a few years, and makes the following suggestion as to obtaining a reliable basis to calculate the probable cost:—"Let the Government spend £1,000 on forms of application for telegraph shares, these shares to consist of books of forms, similar to those in use, with an embossed sixpenny stamp, the purchaser of these shares to have the benefit of a reduction of 5 per cent. for payment in advance. The forms to be used within the first year, if not so used, a surcharge of 1d. to be made in all such forms tendered after the first year."

INTERNATIONAL ELECTRICAL EXHIBITION AT PARIS.—It is officially notified that the Electrical Exhibition, which was to have closed on the 17th instant, will remain open until to-morrow evening, the 20th instant. The Exhibition will be

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thrown open to the public gratis during the usual hours to-day and to-morrow. Amongst the visitors on Saturday last was Prince Leopold, Duke of Albany. To celebrate the success of the Exhibition the French workmen have invited their foreign brethren to a dinner at the Palais Royal on the 22nd inst. M. Berger will preside, and the entertainment will be under the patronage of M. Cochéry, the newly re-appointed Minister of Posts and Telegraphs.

Herring Fishers and Cables.—There has been some very sharp criticism expressed concerning the action of the herring fishers towards those engaged in cable work. We believe that some eleven wires are at present requiring repair among those joining this country to the Continent, and that the repairing operations are almost at a standstill because the men on board the boats engaged in the herring fishing, sink or otherwise destroy, or move the buoys used in the cable work. If free communication is to be maintained, and these acts of stupidity and ignorance continue, it will be necessary for the Government to take some stringent measures to restrain the operations of the fishers to their rightful channels.

The Telephone in London.—Mr. J. W. Batten writes to *The Times*, under date 9th November, as follows:—"It is now little more than ten months since I ventured, when addressing a meeting of the Statistical Society, to assert that if the Postmaster-General granted a license for the use of telephones in London, the United Telephone Company, of which I was a director, would undertake to supply London with a penny telelogue in lieu of or in addition to the shilling or sixpenny telegram. That pledge has now been fulfilled, for last week the United Telephone Company passed along its wires 19,522 messages a day for 1,218 subscribers, at a total cost to them of £81, being as nearly as possible, one penny per message." Mr. Batten goes on to prove by statistics that this has been accomplished without injury to the postal telegraph.

Magnetic Survey of Missouri.—Writing on this subject to *Nature* of the 10th November, Mr. F. E. Nipher, of St. Louis, U.S.A., says:—"The work of the past summer has increased the complexity of the isogonic lines, and the gradual change in declination in passing through these areas of abnormal value shows that the causes must act over areas of from 1,000 to 3,000 square miles, *i.e.*, that the observed effect is not due to minute local causes at the several stations. It will not be possible to determine fully the extent of these abnormal influences until similar work done in adjoining States shall enable a more precise determination of normal values. The stations of observation in Missouri now number over 100. Arrangements for the summer of 1882 have already been made, and the survey will be carried forward on a still more extended scale."

The Telephone in Greece.—It is stated that telephone lines have recently been erected between Athens and the Piræus for the use of the Minister of Marine and War. The distance between the two stations is 10 kilometres, and the two lines are erected on the same posts, the wires being separated by a distance of about 20 centimetres. The instruments are those of M. Ader, of Paris, and were made by M. Breguet. The effects of induction are said to be very small. One of the lines is connected with a submarine cable of 11 kilometres long, and correspondence is easily maintained. In addition to these two lines, the King is in telephonic communication from his apartments with four different parts of the town by means of the same instruments. The lines have been erected by a Greek engineer of the name of Aygropoulos, and are, we believe, the only telephone lines at present in existence in Greece.

Lecture on the Electric Light at Alfreton.—Mr. J. A. Longden, of Blackwell, recently read a paper before the Alfreton Institute and Club, the title of which was "A Visit to the Electric Exhibition in Paris, and the Use of the Electric Light in Coal Mines." Mr. Longden gave a good account of the various exhibits, and referred more particularly to the electric light. With reference to the employment of the latter in mines, and the question of the breaking of the leading wires, whereby a spark might occur which would fire a gassy pit, Mr. Longden said he had been talking to Mr. Swan's engineer, and that he had told him that an automatic cut-out had been devised, which would come into play at once when the regular current was interfered with, and prevent any possibility of sparks being emitted. The hall where the lecture was given was lighted up at intervals with British incandescent lights, suitable for various purposes, supplied by Mr. Sydney F. Walker, M.S.T.E., of Nottingham, who explained the system on which the lamp was constructed, &c. He also stated that he had recently fixed two arc lights in a mine in the Rhondda Valley, South Wales.

Harold v. The India Rubber and Gutta Percha Company.—This case came before Sir C. Hall in the Chancery Division of the High Court of Justice recently. It was an ex parte application for an interim injunction to restrain the defendant company from laying or shipping for transmission abroad a certain submarine cable. The plaintiff in 1879 and 1880 obtained a concession from the Governments of Columbia, Peru, and Ecuador to lay a cable which was to extend from Guaguile to Lima. It was intended that the telegraph lines should join at Callao, in Peru, with the coast telegraph in Valparaiso and the Argentine Republic. The concession was for twenty-five years. It, however, had recently come to the knowledge of the plaintiff that the defendant company were about to ship a submarine cable, to be laid in the route which had been conceded to him and his associates exclusively. If the defendants' cable were laid it would entail a serious loss and injury to him. The Vice-Chancellor said he could not grant an injunction restraining the company from making or shipping this submarine cable, but he would grant an injunction restraining the company from laying or working the said cable. The plaintiff, however, would have to give the usual undertaking as to damages.

Crystal Palace International Electric Exhibition.—We are informed that the authorities of the Crystal Palace sent out on Saturday last the allotments of space to the principal exhibitors of electric light at the forthcoming exhibition. If the various electric lighting companies and firms carry out their promises and intentions the Palace will be lighted from the London, Brighton, and South Coast Railway Station to the North End. The following allotments have been made:—The Anglo-American Brush Electric Light Corporation, the Electric Light and Power Generator Company, Mr. Graham, of Glasgow, with a new lamp, the British Electric Light Company, Messrs. R. E. Crompton and Co., Messrs. Rowatt and Fyfe (the Pilsen and Joel light), Mr. Edison, Messrs. Strode and Co., M. Gravier, M. Gérard, Messrs. Siemens Brothers and Co., Messrs. Hammond and Co. Mr. R. Mackie (for the White House Mills Company), Messrs. Hawkes and Co., M. Werdermann, and M. Gaudet (on behalf of the Compagnie Générale d'Electricité). The consideration of applications from intending exhibitors in other classes than that of lighting has been proceeded with during the current week, and it is hoped that the allotments will be issued to-day or on Monday next.

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ELECTRICAL DIRECTORY OF ENGLAND FOR 1882.—Under this title Mr. J. A. Berly, C.E., &c., is about to issue a work which he calls "The Electrician's Vade Mecum," and which will contain a complete record of all the industries directly or indirectly connected with electricity and magnetism, together with the names and addresses of manufacturers, &c. We have been favoured with proof sheets indicative of the general plan of the work. At the beginning of the book there will be a general alphabetical index to the trades, which are themselves arranged in alphabetical order in the body of the work; for instance, say we want to find the manufacturers of electric lamps, we refer to the index, and under the head "Electric Lamp Manufacturers" we find a cross reference to arc and incandescent lamps. Suppose we wish to find the former we turn to A, and are referred to page 2 (say), on turning to page 2 we find the names of the manufacturers arranged in alphabetical order, and so on for all the numerous trades that have of late years become connected with the various applications of electricity that have sprung up. It is not easy to judge of the value of a work by a few specimen pages, and we cannot, therefore, express any opinion in this direction. What we can say, however, is that the idea is a good one, and if well carried out should supply a felt want. The book will be of a handy size (demy 8vo.), and the cost to subscribers will be 2s. 6d. It is intended to bring it out once every year, the forthcoming issue being for 1882. We reserve our opinion of the book itself until it is in our hands. In the meantime we wish Mr. Berly all success.

THE RELATION OF ELECTRO-MAGNETIC AND ELECTRO-STATIC UNITS.—At a recent meeting of the French Physical Society, Professor Stoletow, of the Moscow University, described an apparatus which he has used to determine the relation of electro-magnetic and electro-static units (the v of Maxwell). The electro-static capacity, C, of a condenser formed of two plates with plane and parallel faces, one of which is furnished with a guard ring, is equal to $\frac{S}{4\pi\delta}$, S representing the surface, and δ the distance between the two plates. The electro-magnetic capacity is $\frac{C}{v^2}$. This condenser is charged from a battery, and the discharge passed through a galvanometer; when a hundred discharges are produced per second a permanent deviation is obtained on the galvanometer. Let i be this deviation, A the constant of the galvanometer, n the number of discharges per second, F the electromotive force of the battery—we have $n\,F\,\frac{C}{v^2} = A\,i$. Cut out F and A by observing the deviation produced by a small part of the current direct from the battery, transmitted through a resistance box and shunt. To find C we must be able to exactly measure δ. This is done by means of microscopes with micrometric eyepieces, which sweep the edges of the lower and upper plates, and of the guard ring. The n discharges per second are obtained by means of a revolving commutator, set in motion by a small Helmholtz electromotor, the number of revolutions of which are registered by a chronograph. The value ascertained by Professor Stoletow agreed with those previously given, viz.:—298,000 to 300,000 kilometres per second.

ELECTRIC MOTORS.—M. Gravier writes to *La Lumière Electrique* of the 22nd of October as follows:—"A Gramme machine, size A, excited by a current from some external source, revolves at a speed of 1,024 revolutions per minute. A second similar machine is connected to the first by a conductor of about 200 metres, and is free to revolve under the influence of the current from the first machine. When this latter is prevented from revolving we observe on a thick wire galvanometer an intensity of 30 ampères; on a fine wire galvanometer a difference of potential of 86 volts. If the coils of the second machine be allowed to revolve freely, we notice that the intensity is reduced to 8 ampères. This is explained by saying that an inverse electromotive force is developed in the coil, and annuls a portion of the electromotive force developed by a generating machine. In this case the fine wire galvanometer should indicate $E - e$. Nothing of the sort; the fine wire galvanometer always shows $E = 86$ volts, and that whatever be the speed of the motor coil. The intensity alone varies. The difference of potential remains constant. If we place a second Gramme machine, identical with the others, near to the motor and connected with it by a shunt circuit, and if we allow it to revolve freely, it will exhibit the same speed, and the galvanometers will show 18 ampères as the intensity of the current in the machines, and invariably 86 volts as the difference of potential at the entrance and exit of the current in these machines. If we place a third machine by the side of the two first it also shows the same speed, and is traversed by a current of eight ampères and 86 volts. If we admit that $I = \frac{E}{R}$, it would seem, as the result of these experiments, that R increases with the speed. But, as far as I can see, R cannot change. The physical conditions of the coil remain the same, we may say, for the quantity of heat developed in the circuit cannot so largely affect R. If we stop the motion we shall find the true value of I. R depends on the speed of rotation of the coil, and if we increase its speed, mechanically, we arrive at a limit where $R = O$. I believe I know the cause of this, and shall have more to say on the subject and its bearings on the construction of electric motors in a future issue of your paper. In the meantime, I offer my experiments to the savants as a foundation for a mathematical law explaining these new facts. I place myself at their disposal, and shall be glad to repeat the experiments in question, if necessary." M. A. Clamond writes in a subsequent number of our contemporary in reply to the above:—"These facts are not new, and are explained by Ohm's law. M. Gravier having shunted his first machine through a galvanometer of high resistance, graduated in volts, which should give him the difference of potential at the two terminals, is surprised that this galvanometer only gives him results which it is constructed to give. He seems to forget that when he shunts a portion of a closed circuit through his galvanometer, in which circuit a current is passing owing to the action of electromotive forces of different signs, this galvanometer will only indicate the difference of potential between its two points of connection, and not the algebraic total of the electromotive forces at work in the circuit. He should only expect to get the indication $E-e$. I beg M. Gravier to try the following:—Having connected his fine wire galvanometer with the two poles of a Daniell cell, let him note the exact E.M.F., say 1·08 volt. Let him then connect this cell by means of a conductor 200 metres long, interposing his thick wire galvanometer, with the opposite poles of a second Daniell cell of the same E.M.F. as the former. His intensity galvanometer will indicate zero, and he will explain this by saying that the inverse E.M.F. of the second couple equals the E.M.F. of the first, but will be surprised to see that his fine wire galvanometer still indicates 1·08 volt."

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THE ELECTRICAL EXHIBITION AT PARIS.

Hitherto we have spoken of the lamps of Mr. Swan and of those of Mr. Edison belonging to the incandescent system. These, indeed, are more widely known than other incandescent lamps, and were shown at Paris in large numbers. These, too, have been tested by public use more or less completely—the Edison lamp not so much so, perhaps, as the Swan lamp. Then, again, Edison's system viewed as a whole is wonderfully complete, whilst the other inventors have confined their efforts to the production of a lamp, or at most to a lamp and a system of controlling the current.

The lamp of Lane-Fox is spoken of by those who have tested it as quite equal if not superior to its competitors. It must be distinctly understood that in this case, as also with the Maxim lamp, our information is from various sources. We have not had these lamps under test, nor, indeed, have we been able to obtain the results of any independent test. The inventors of lamps may perhaps like to know that we are quite willing to put any lamps through a series of tests if specimens are sent to us for that purpose. We generally find, however, that inventors are by no means in a hurry to let their inventions be submitted to such independent tests. The most interesting information we have relating to the Lane-Fox lamp is that given by the inventor in his paper to the Society of Telegraph Engineers, and published in the May number of the *Journal*, the discussion in the paper occupying part also of the June number of the *Journal*.

Before fully describing the lamps it may be interesting to know that great preparations are being made to manufacture this lamp on a large scale. We are told that when the factories are quite ready it will be possible to turn out 50,000 lamps per day. Quite recently great complaints have been made that the resistance of the Swan lamps is so variable that great difficulties are placed in the way of using them. The resistance of each lamp issued should be marked upon it, and some idea or guarantee should be given as to the average life of a lamp. We are told that Mr. Lane-Fox is prepared to guarantee a certain average life to the lamps issued by him, and if this is correct it is not merely a step, but a vast stride in the right direction. Then, again, his arrangements are so complete that he is prepared to supply lamps of any required resistance. His carbon is accurately gauged before being put into the lamp, very carefully sorted, and every care taken to obtain in lamps of the same pattern carbons of the same resistance, of the same homogeneity, and having the same lasting power. Of course it is practically impossible to obtain exact counterparts for each lamp; but so far as it is possible we have every reason to suppose that Mr. Lane-Fox is prepared to guarantee.

It may, perhaps, be deemed that we are not altogether correct in saying that Mr. Edison alone has devised a complete system, it may be claimed that Mr. Lane-Fox has such a system. This is so far true that while the lamp and apparatus for regulation is designed by Mr. Lane-Fox, he is working in connection with the Anglo-American Company, who supply the Brush machines; hence the Brush machine and the Lane-Fox apparatus to a certain extent form a complete system.

This lamp is very similar in appearance to those of Swan or Edison. The light is obtained from an incandescent strip of carbon fixed in a vacuum. The differences are in the kind of carbon and in the details of fixing. The inventor states that he has tried many materials for the purpose of obtaining carbons, all with more or less success. Any form of carbon, he states, will continue in a high state of incandescence without deterioration, provided that it is properly mounted and enclosed in a good vacuum. If the carbon is raised above a certain temperature it is rapidly destroyed. This has long been understood by all inventors of incandescent lamps, and hence, in order to obtain a long average life for the carbon, the temperature to which it is raised is comparatively a low one. If, however, on the one hand there is the great advantage of lengthening the life of the carbon by pursuing this course, on the other hand a greater amount of light is obtained per pound of coal burned by the engine by raising the carbon to a higher temperature. The problem of the temperature of the greatest economy for each particular lamp, all things being considered, is one of great difficulty, but it is being solved, though but gradually, by experience.

The carbon for this lamp is obtained from cotton baked in a hermetically sealed vessel at a white heat. Other vegetable fibres may, however, be used, and a harder and more durable carbon may be obtained by heating this conductor to incandescence while immersed in a hydro-carbon liquid or gas. In

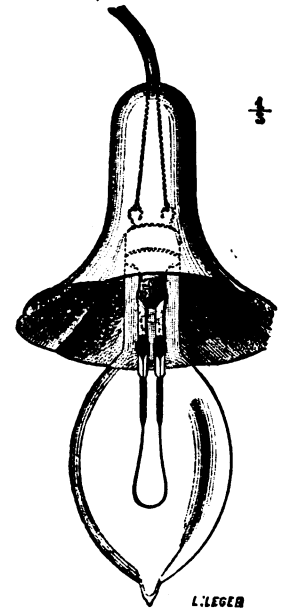

FIG 1.

our issue for March 5th we described and illustrated one form of this lamp* which may again be briefly referred to. Conducting wires from the machine dip into mer-

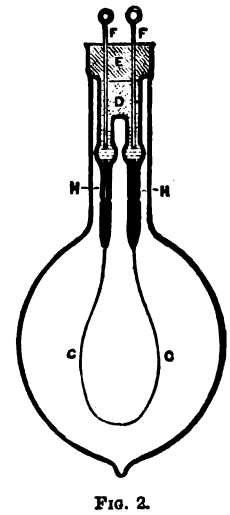

FIG. 2.

cury tubes. Small platinum spirals are fused into the glass and also have one end in contact with the mercury. The carbon to be rendered incandescent is fixed to these platinum spirals. The inventor relies greatly upon his vacuum, which is not obtained by the Sprengel pump, but by the aid of a mercury or acid apparatus, as explained below, while the carbon is incandescent. When a sufficiently high vacuum has been obtained, the globe is

* See *The Electrician*, March 5, 1881, Vol. VI., p. 196.

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hermetically sealed where connected with the exhausting apparatus. Ground glass globes are frequently used in order

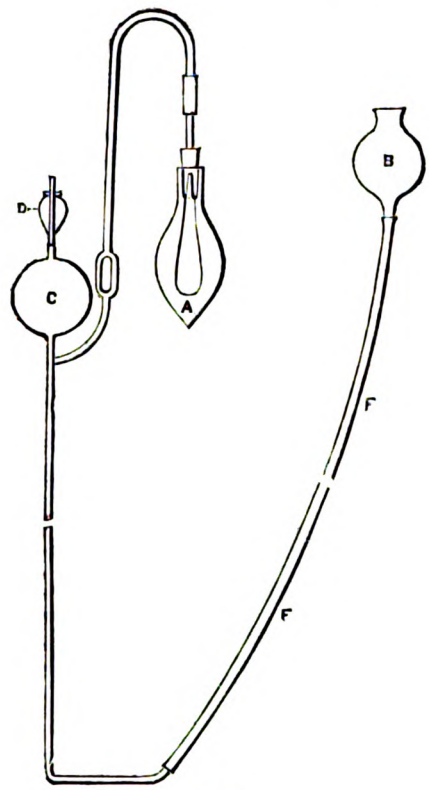

Fig. 3.

to obtain better diffusion of the light. The accompanying figure (Fig. 1) shows a lamp with a bell-shaped reflector, as

will be better understood by a reference to the illustration. The pieces of platinum wire are still fused

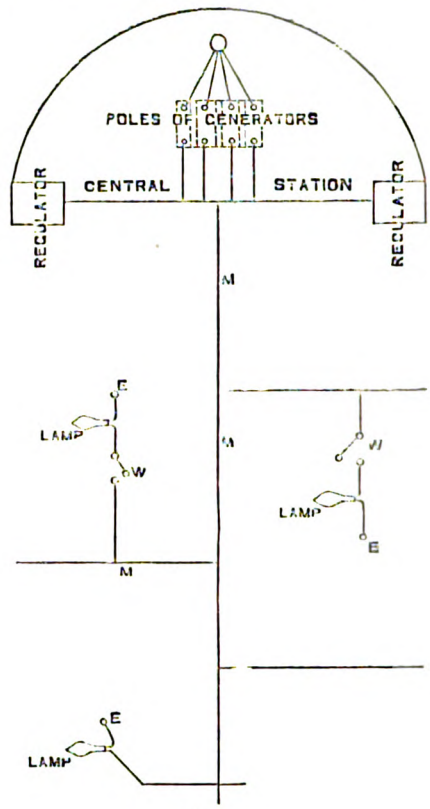

Fig. 5.

into English lead glass, and have one end in contact with mercury, but the contact between the carbon filament and

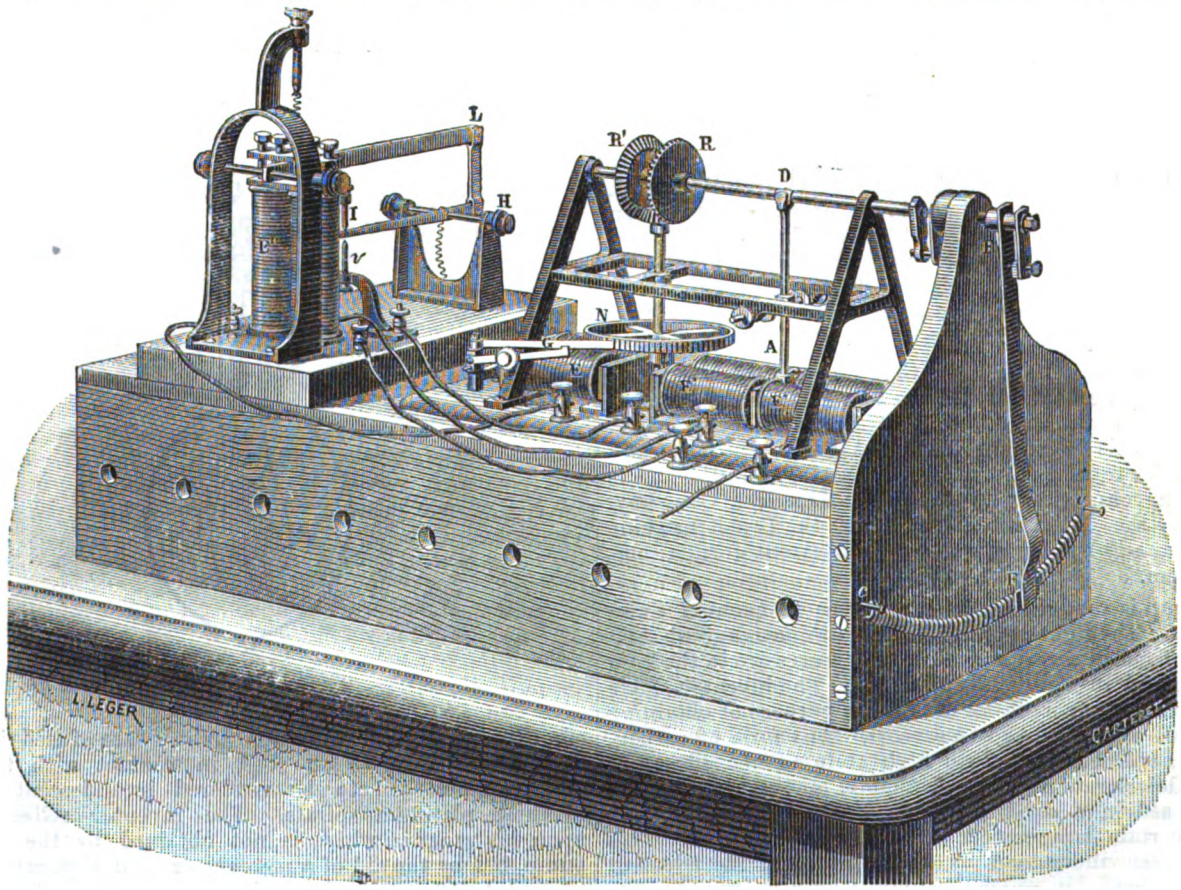

Fig. 4.

exhibited at Paris. Some slight modifications have been introduced into the lamps of recent manufacture, which

the platinum wires is modified. A small cylinder of carbon is taken, and a hole bored so as to admit one end of the

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platinum wire, or the hole may be bored quite through admitting the end of the platinum on the one side, and the end of the carbon filament on the other. Good contact is made with the carbon, and hence between the platinum and the filament, by the use of genuine Indian or Chinese ink. Above the mercury (Fig. 2) is a plug of wool, and above that a mass of plaster of Paris.

It is stated that 15 lamps, each giving a light equal to twelve standard candles, are obtained with an expenditure of energy equivalent to two horse-power, the resistance of the lamps cold being about 80 ohms. The following is the table given in the paper referred to above. One or two experiments were made, and the figures given calculated, so that they must be taken as only approximately true. The calculations were made "so as to give an idea of what the resistance of a lamp should be to suit any electromotive force, and to show that, by using a somewhat higher degree of electromotive force in the system, the resistance for the lamps would have to be increased in a much greater proportion."

Electromotive Force in Volts.	15 candle-light luminous bridge, having 1-10 sq. in. radiating surface, absorbing 1-10 H.P., has a resistance in ohms of	7½ candle-light luminous bridge, having 1-20 sq. in. radiating surface, absorbing 1-20 H.P., has a resistance in ohms of	5 candle-light bridge surface = 1-30 sq. in.; H.P. absorbed = 1-30 resistance in ohms.
30	11·95	23·90	35·85
40	21·25	42·50	63·75
50	33·21	66·42	99·63
60	46·77	93·54	140·31
70	65·10	130·20	195·30
80	85·03	170·06	255·09
90	107·62	215·24	322·86
100	132·87	265·74	398·61
110	160·77	321·54	482·31
120	191·3	382·6	573·9
130	224·55	449·10	673·65
140	260·43	520·86	781·29
150	293·96	597·92	896·88
160	341·	682·	1,023·
170	384·03	768·16	1,152·24
180	430·5	861·	1,291·5
190	479·67	959·34	1,439·01
200	531·49	1,063·98	1,594·47

It will be sufficient if we describe one of the kinds of apparatus employed in exhausting the globes (Fig. 3). A vertical glass tube 30 inches high or more terminates at its upper end in the bulb C, having a ground neck into which is sometimes put the lower end of a glass rod. The neck opens into another bulb, D, through the neck of which also the glass rod passes. This higher part of the glass rod is covered with india rubber or other suitable material, so that the rod, whilst capable of being forced up or down to close the lower neck, always preserves a tight joint in the upper neck. A cup can be connected above D. To the lower end of the glass tube is connected a piece of strong flexible tube, F F, longer than the glass tube, to the other end of which an open vessel, B, is fitted. To the glass tube, and just below the bulb C, is another vertical tube carried above the level of the cup to be fixed to D, then bent round and hermetically fixed to a tube, which communicates with the interior of the lamp globe. The action of this apparatus is very simple. The vessel B is partly filled with mercury when in a low position, then raised, when the mercury rises in the vertical glass tubes filling the bulbs and up to the cup. The neck of the upper bulb is closed, the lower one being left open. The vessel B is lowered so that the mercury falls well below the opening of the side vertical tube into the other tube. This action produces a vacuum in the bulbs, which are then filled by air from the globe. On repeating the operation with the upper neck open the air in the bulbs escapes. It will be seen that the opening of the side tube must be sealed by mercury before the air in the bulbs is allowed to escape. The degree of exhaustion then simply depends on the number of times the action is repeated and the proportion between the size of the bulbs and the lamp. Thus, suppose the bulbs to hold nine times the contents of the globe—for simplicity neglecting the connecting tubes—then on lowering the mercury the air in the globe expands and occupies ten times its original volume, decreasing correspondingly in density—*i.e.*, 9-10ths of the air in the globe is removed by each cycle of operations.

The method adopted to keep the electromotive force in the mains constant is as follows:—An electro-magnetic apparatus, Fig. 4, which may be called an electro-dynamometer, is connected with the main. The electro-magnet E forms a shunt of very high resistance, so that a very small quantity of the current goes through it. Any variation in the current, however, in the mains also means a variation through E, and a variation in its attraction of the armature L. The armature L acts on a contact maker, with contacts I, *v*, sending if required a current through electro-magnets E E′ E″. These magnets acting on their armatures, in the one case act through the rod G upon the wheel N on the pinion shaft, and in the other on the shaft A through D, causing the bevel wheels R to gear with the pinion. Power enough can thus be obtained to operate a large throttle valve, or the expansion gear of an engine, or any suitable regulator of the motive power. If, then, any increased current is needed by more lamps being placed in circuit, or other resistance to be overcome, E¹ as described, acting by its armature upon the apparatus, increases the supply of steam, gives more power, which acting on the electric light generators gives the required current. The reverse action takes place if less current is required.

We now come to the method adopted for the distribution of the current to the lamps. The illustration almost explains itself. One pole of each generator is put to earth, particular attention being given to the fact that the earth contact is good. The other pole is connected with the street mains. From the mains branch off wires in any direction required to the lamps. One pole of the lamp is put to earth, the other being connected to a switch, by means of which the current can be switched on or off the lamp as desired. In Fig. 5 M indicates the main wire, W the switches, and E the earth connection. We have thus given a brief description of the Lane-Fox system, which, we believe, will be exhibited also at the forthcoming Exhibition at the Crystal Palace, when even a better show may be made than at Paris, if such a thing be possible.

GREAT WESTERN BRAZILIAN TELEGRAPH COMPANY *v.* BIBBY.—This was a case brought before Mr. Justice Chitty in the Chancery Division of the Supreme Court of Judicature on the 15th of November. The action was brought to recover the sum of £300,000 from the directors of the company on account of profits alleged to have been improperly made by them on certain transactions. In order to carry out the objects of the company a cable had to be purchased, and a contract was entered into with Hooper's Telegraph Company. According to the statement of plaintiffs' counsel, the promoters, directors, and others interested in getting up the company agreed in the price of the cable being heavily "loaded," and a considerable proportion of the profit had been distributed amongst the promoters and directors, which it was sought by this action to have paid over to the company. Mr. Ince, Q.C., now moved for judgment against the defendant in default of pleadings. Mr. Justice Chitty held (in accordance with the minutes signed by counsel) that £180,000 paid by Hooper's Telegraph Company to Mr. Erichsen, £7,000 paid to Mr. Rawson, and £3,000 paid to Mr. John Heugh, before the incorporation of the plaintiff company, and the value of fully paid-up shares of the nominal amount of £110,000, transferred by Hooper's Telegraph Company to Mr. Erichsen, were respectively the property of the Great Western Brazilian Telegraph Company; that such payments and transfer were made in breach of trust; and that Mr. Tietgen, as a director of the latter company, was liable to make good to them the total amount of £190,000 cash and £5,500 shares so received, at their then market price, and to pay also the cost of these proceedings.

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THE COST OF ELECTRICITY.

Under this heading, and a similar one relating to electric lighting, a number of letters have recently appeared in the daily and weekly papers. It is evident that the public are getting a little impatient at the non-fulfilment of prophecies confidently, but perhaps too unguardedly, formulated by the professional friends of electricity. We are as sanguine as the most enthusiastic of prophets; but we are not in such a hurry. Although the persons who write to the newspapers may be, as indeed they are, unreasonable in expecting electricity to do for them at once what it has taken twenty or thirty years for gas to accomplish, it was equally unreasonable to make promises encouraging such expectation. We have always discountenanced misleading speculations on one side or the other; and while we have never doubted the final results, we have steadily faced the difficulties to be overcome. Nor have we ever pretended that success would be instant and overwhelming; there are sufficiently obvious and natural reasons why progress must be comparatively slow. If these reasons had been duly considered in certain quarters the irritation manifested by the public just now would not have been aroused. It cannot be doubted that the exaggerated expectations imported from America a couple of years ago, and which were doomed to disappointment, did much to discredit the electric light as a profitable investment. Similar exaggerations nearer home have tended in the same direction. The application of electricity for mechanical and illuminating purposes cannot be proceeded with while capital is shy; and capital is shy only when there is lack of confidence. Such complaints as are now being made from day to day by private individuals who want but cannot obtain the services of electricity are calculated to disturb the faith of capitalists in the promises of electricians. If capitalists were electricians, or, better still, if electricans were capitalists, knowledge and prudence would work hand in hand; but as this combination is impossible, or possible only in rare instances, the next best thing is to inspire confidence by solid evidence that shall be at once trustworthy and complete.

It is much to be regretted that such evidence is not yet forthcoming, as is evident from the ludicrously contradictory statements continually put forward by all parties alike with respect, for example, to the cost of electric lighting. It is much cheaper than gas, it is ten times dearer than gas, it is nearly as cheap as gas; storage will render it cheap and popular, storage will make it more cumbersome than ever, storage only makes it dearer. These, looking at the figures presented to the public, are the data on which its patronage is to be invited. The only persons really able to elucidate matters are the patentees—or rather, as has been correctly pointed out, the company proprietors of patent rights—and these are for the most part either reticent or vague. In one or two notable instances calculations have been worked out without reserve, and we have done our best to give them publicity; but these are the exceptions, and the correspondents who, with the best intentions, have essayed to answer the complaints above referred to have had to resort to the mere flourishing of grand assertions or obscure generalities. All this while the fact that electricity *is* cheaper than gas is known to be an indisputable proposition; but the equally important fact, which one side cannot appreciate and the other side will not frankly admit, is that the conditions must be alike if a fair comparison is to be made.

It is this unrecognised fact which underlies most of the disappointment now finding expression in the newspapers. That a telephone cannot be purchased and used as cheaply as popular expectation was led to reckon upon is accounted for not by the cost of electricity, but by commercial considerations, including the operation of patent laws, which, for a time at least, always hamper the usefulness of every new invention. That electric lighting for domestic use is similarly handicapped is unquestionable, but in this case there is another and more serious hindrance, namely, the presence of an established rival, who must not merely be deserted but banished before the new love can fairly be said to be on. At least this is the conclusion to which all the correspondence points. I wish to light my house with electricity, says one, but am told that the cost will run me to some £400 or £500 to begin with. For this he is scolded very roundly, and told that somebody whom the writer knows, but does not name, will do the job for several pounds less; and, what is more to the point, that nobody can reasonably expect to have electricity "laid on" like gas until a number of other people—in plain language, the whole district—agree to do likewise. This, of course, is true, and it is what we have got to wait for, and not to be in a hurry for; but it is precisely what the British public were not apprised of when they were ardently invited to be off with their old love. To have a common centre for supply means that you must have a common circle of demand; in other words, everybody must turn out gas and take in electricity. A very desirable end, truly, but the mere statement of it shows how formidable and how slow the process must necessarily be.

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If, however, private individuals must be content to wait, public works and large factories can be promptly and economically satisfied. Leading thoroughfares in our large towns can, and ought to be, lit up at once, with advantage to everybody concerned. The Strand, for example, from seven o'clock to midnight is at present a frightful hurly-burly of rattling vehicles, maddened horses, and infuriated policemen. If the benighted foot-passenger escape these dangers, and wend his way either eastwards or westwards, he will probably ask one or two pertinent questions. From the semi darkness in which the neighbouhood of theatres is generally enveloped he may emerge upon the forsaken but brilliantly gas-illuminated region of Westminster; or he may traverse the solitude of Cheapside refulgent with the best lights that electricity can bestow. This is not as it should be, for it countenances the prevalent notion that the electric light is spectacular rather than useful. Every fresh region of practical usefulness counts, therefore, as real gain; and that the gains are by no means few in number our columns week after week bear ample testimony. Surely, if slowly, these regions will extend to quarters where domestic life abounds—which is certainly not the case in the places we have just named—and then will be the opportunity to test the economy of electric lighting in the house of anybody willing to try it. If the public who profess to be anxious to introduce electricity into their dwellings were told this plain truth about it oftener than is done at present, one very useful purpose would be served—they would agitate for its introduction in their neighbouring thoroughfares. That is the first step, a step which they alone can take, and which probably they would take if they were better advised.

SHIPS' LIGHTS.

The following letter has been addressed to the Board of Trade by Sir J. Anderson, on the subject of ships' lights:—

(Copy.)

Eastern Telegraph Company (Limited), 66, Old Broad-street, London, E.C., 24th October, 1881.

Sir: I had the honour of addressing you on the 2nd October, 1880, in reference to Article 5 of the International Steering and Sailing Rules, dated 14th August, 1879, requiring that vessels in distress should show the same signals as telegraph ships at work, but as yet no alteration has been made in the rule referred to.

The captain of our ss. "Chiltern" complains bitterly of ships bearing down upon them while repairing in the Straits of Jubal, believing them to require assistance, to the danger of fouling the cable.

I beg also to call your attention to the following:—

Repairing cables has now become a constant employment in various parts of the world, and as cables grow older will probably become still more so.

There are now no fewer than twenty-five steamers almost continuously employed in laying and repairing telegraph cables; and as their signals by day and night are becoming familiar to vessels of all nations, the time may not be far distant when a ship in distress—however urgent the case—may meet with no attention whatever, as commanders will come as a matter of course to regard the signals of distress as those of some telegraph ship.

This matter is so obviously in the interests of the public that I would urge the immediate consideration of it upon your department.

It is surely not worth while incurring the responsibility of a foundering ship being neglected, and loss of life ensuing, owing to the needless similarity of signals referred to above.—I am, Sir, your obedient servant,

(Signed) James Anderson, Managing Director.

Thomas Gray, Esq., Board of Trade.

CORRESPONDENCE.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I do not pretend to correct *all* the erroneous statements made in reference to secondary batteries; but I think that certain portions of the paper by Professor W. G. Adams, as printed in your last issue (p. 412), should not be allowed to pass without comment. It is there asserted that "The electromotive force of a single cell of Planté's battery is about $2\frac{1}{2}$ volts, or $2\frac{1}{5}$ times that of a Daniell cell, *i.e.*, about $1\frac{1}{2}$ times Grove's cell." Now, the very highest electromotive force I have ever observed in a fully-charged Planté cell is 2·018 volts; and this I believe to have been abnormal and due to the presence of some element, more electro-positive than lead or hydrogen, deposited at the cathode. Ordinarily the Planté cell and also the Faure, exhibit when fully charged, an E.M.F. of from 1·81 to 1·92 volt. I am aware that the E.M.F. of the Faure cell is commonly given as 2·2 volts, but my experience is that no cell made up solely with lead, its oxides, and sulphuric acid, can give a difference of potentials even so high as this.

The following statement in the same paper appears to me very misleading, since it altogether ignores the "polarisation" of the cathode plate by hydrogen, and seems clearly to imply that the protoxide of lead may exist as such in presence of the dilute sulphuric acid with which the Planté cell is invariably charged:—

"In charging by sending a primary current through the cell, peroxide of lead is found at the positive pole, and the negative pole becomes somewhat crystallised. When detached, the peroxide of lead forms the positive pole of the secondary battery, and the battery will remain in action until the two plates return to the same state, the positive pole being reduced from the peroxide to the oxide of lead, and the negative pole being transformed from lead to the oxide of lead."

Again, some of your readers must have been somewhat puzzled by the following:—"The cells may be charged by a dynamo machine, and may also be used to drive a dynamo machine like an electro magnetic engine or motor, driving it *in the same direction as it was driven when used as a generator to charge the cells.*" This seems to imply, in contradiction to generally received notions as to the conservation of energy, that after we have charged a secondary battery by means of a dynamo machine this will continue moving, independently of its steam motor, in the direction requisite to produce (or augment) the charge.

In conclusion, I may observe that in "renovating" an exhausted Leclanché battery by means of a current traversing it from carbon to zinc, it is necessary to add sufficient ammonia to neutralise the hydrochloric acid which otherwise is set free at the anode.—Yours, &c.,

Desmond G. FitzGerald.

REPORTS OF THE "CHALLENGER" EXPEDITION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your article on the ocean bed you refer to the above reports, and briefly remark that these reports should be in the hands of all students, or, at least, accessible by all. I think it ought to be insisted more strongly than you have done that these reports on information obtained by men paid with public money to get it, and with a ship and apparatus also supplied by the public money, ought to be printed in large editions at a cheap rate. Why are we to pay men to get this information and then allow them to withhold it from us by printing it only in books which are issued in comparatively small numbers at a very high price.—Yours, &c.,

Student.

Erratum.—In Mr. Arthur Wright's letter on "The Measurement of the Electric Light," which appeared in our last issue, the word "above" in the 23rd line from the bottom of the first column should be "about."

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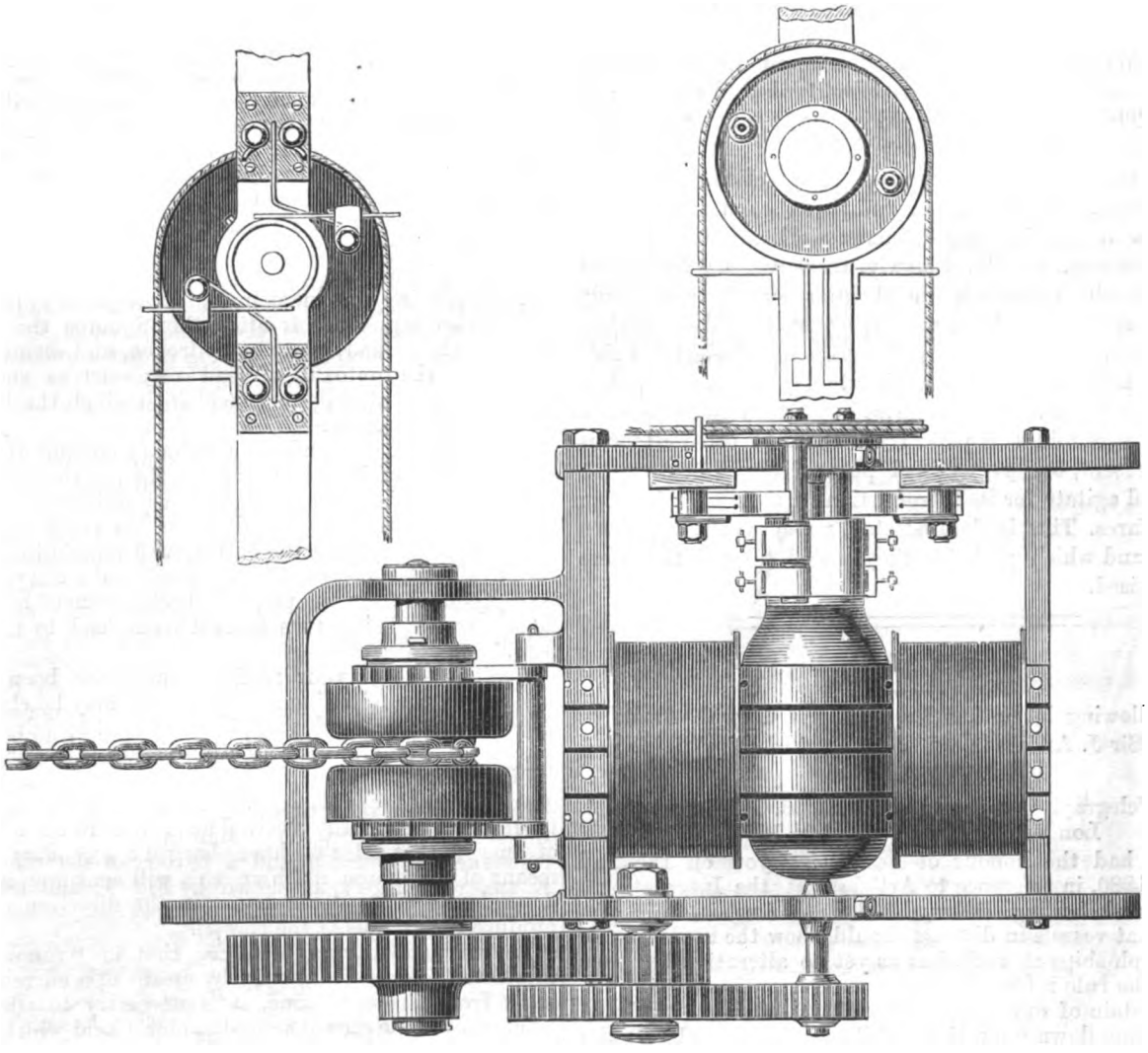
THE ELECTRICAL EXHIBITION AT PARIS.

Hopkinson's Electrical Hoist.

Messrs. Clark, Muirhead, and Co., among other things, show a good example of the use of electricity for business purposes, in actuating a small hoist by its means. The hoist has been designed by Dr. Hopkinson, F.R.S., and is intended to be used instead of pulley blocks. There are many places where space is too limited to admit of a complication of ropes or gearing, and in such cases an electric current, carried by a wire, offers a means for the utilisation of power which will prove of great convenience. The installation of a dynamo-machine may be a matter of considerable moment, if it is to be used solely for electric light purposes; but if it can be used for the transmission of power the difficulty will be lessened. We are told that in the block of buildings in New York which Mr. Edison is preparing to light on his system, energy amounting to nearly 2,000 h-p. will also be required to be electrically transmitted to work lifts and small machines of that kind.



The hoist shown at Paris by Messrs. Muirhead will lift about 5cwt., held directly by one of the hooks, or double that weight if a snatch-block is used, and the apparatus itself weighs about 2cwt. It is easily hung overhead by two chains. The motor is a small Siemens machine, which through gearing drives a chain pulley, within which is a Weston clutch, which comes into operation when the attendant accidentally or intentionally lets go the rope which controls the commutator. Over the pulley is a chain with hooks at both ends, and as the system is completely reversible, the weight to be raised can be attached to either hook. The reversal is effected by a movement of the commutator brushes, controlled by a small rope. On pulling one end of the rope the chain is wound up in one direction; on pulling the other end the chain is wound in the other direction. The speed of lifting, of course, depends on the power employed. Any ordinary electric light machine would probably be capable of causing the hoist to lift 5cwt. at the rate of 2ft. per second.

THE LATE RIGHT HON. W. N. MASSEY, M.P.

Obituary Notice.

The Right Hon. W. N. Massey, M.P., who was a director of the Eastern Extension and Globe Telegraph and Trust Companies from their commencement, died on the 25th of October, at his residence in Chester-square, at the age of 72, having been born in 1809. He was descended from the family of the late Lord Clarina.

Mr. Massey was called to the Bar in 1844, and joined the western circuit. In 1852 he was appointed recorder of Portsmouth, and in 1855 of Plymouth. He entered Parliament in the same year, in the Liberal interest, as one of the members for Newport, for which constituency he sat till 1857. He then represented Salford until 1865, when he was appointed a member of the Council of the Governor-General of India, and was nominated to the office of Finance Minister there, when he was sworn a member of the Privy Council. He retired in 1868, and in 1872 he was returned as one of the members for Tiverton.

Mr. Massey was Under Secretary for the Home Department under Lord Palmerston's first Administration, and in

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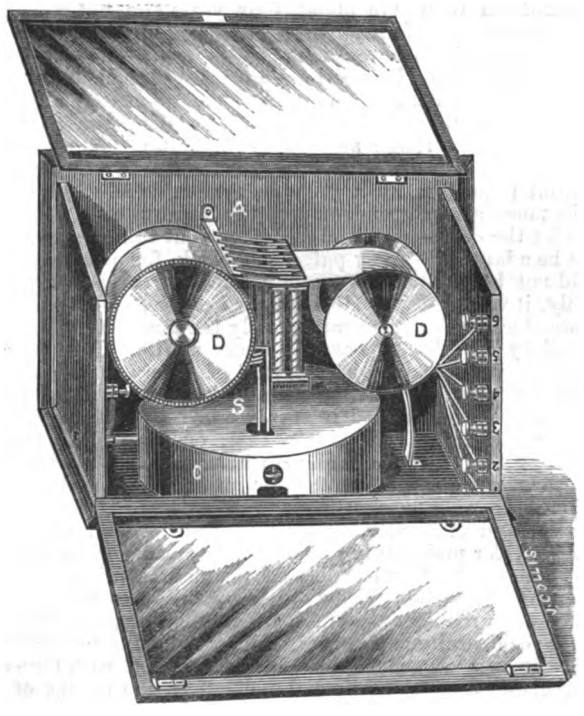
1859 he was appointed Chairman of Committees of the whole House. He was the author, *inter alia*, of a "History of England Under George III.," and of "Common Sense *versus* Common Law."

Mr. Massey married, first, in 1832, Frances Carleton, daughter of the Rev. John Orde, and was left a widower in 1872; second, last year, Helen, daughter of the late Mr. Patrick Grant, sheriff clerk of Inverness.

For the last twelve years Mr. Massey was Chairman of the National Bank.

ELLIOTT'S WATCHMAN'S DETECTOR.

At various times a number of different apparatus have been designed to enable the employer to assure himself that the watchman he employs really performs his duties. Generally the watchman, or watchmen, in a large factory has to visit every part of the premises periodically during the night. One of the simplest apparatus for detecting any laxity in these visits has been designed by Messrs. Elliott, and has been tested during the past twelvemonths with very satisfactory results. The points to be visited are electrically connected with a central apparatus. The watchman has simply to press a button like that in an electric-bell push. The central apparatus is contained in a case which is locked, so that no tampering with it can take place. The cylinder D, to the right, has upon it a coil of paper tape, one end of which is led under the armatures A of as many electro-magnets as there are points to be visited by the watchman,



and on to another cylinder, D, to the left. This latter cylinder carries a toothed wheel which gears into the pinion S. The pinion is driven by clockwork contained in C. Underneath the armature of each electro-magnet is fixed a metal point, which, when the armature is attracted by the magnet, perforates the paper passing between the armature and the poles of the magnet. The action is, as will be seen, very simple. The watchman presses the button, an electric current is sent through the electro-magnet, the armature is attracted, and a puncture made in the paper. If necessary, the paper can be ruled to show the time at which the puncture is made, but in practice this is found to be unnecessary. The clockwork drives the cylinder at a constant rate, and on unwinding the paper it is not difficult to say approximately the time which has elapsed between the punctures. The apparatus is so arranged when in use that the clockwork is vertical, and not horizontal, as shown in the drawing, which has been made so that the details might be better shown than in the other position.

LITERATURE.

A Handbook of Electrical Testing. By H. R. KEMPE, Member of the Society of Telegraph Engineers, &c. New Edition, Revised and Enlarged. [London: E. and F. N. Spon.]

There is no other text-book on electrical testing which is at all comparable with Mr. Kempe's work; indeed, there are but one or two small books that attempt to treat the subject, whilst the ordinary text-books on telegraphy devote at most one or two chapters to it. The old edition of this work was good, but greatly inferior to the new edition. The author is fully justified in stating that he has added a very considerable amount of new matter, besides thoroughly revising the old. The work is practically a new book, and based upon a plan which commends itself to every one who has had anything to do with students. We have always maintained that an author should never be content with giving only the how, but should always aim at giving the why. This Mr. Kempe has done. In his chapters on testing his plan is to describe how the test is made, then discuss the best conditions for making the test, concluding with an investigation as to the possible degree of accuracy to be attained with the particular test under consideration. Such a method of procedure will soon compel the careful reader to understand why one single method of testing is not rigidly adhered to; he finds that different conditions necessitate different arrangements, and that a test which gives fairly accurate results in one case will not be so accurate in another.

The author commences with a simple example in testing, then in the first four chapters describes some of the apparatus used in testing, coming in Chap. V. to the measurement of galvanometer resistance. He discusses several methods, such as the "half deflection method," "equal deflection method," and Thomson's method, which, however, is an example of the equal deflection method. Although the author as a rule gives his information very fully, there are necessarily places in which the results are written down at once. We have found in using the previous edition, and using other works, that it is an excellent experience for the young student to interpolate the reasoning leading up to the result, and to write out fully the algebra of a formula showing every step taken in his own mind. As an example of what we mean take this description of Thomson's method, which is as follows, p. 65:—Join up the galvanometer g with resistances a, b, and d, and a battery of electromotive force E and resistance r, as shown by Fig. 1, and let a key be

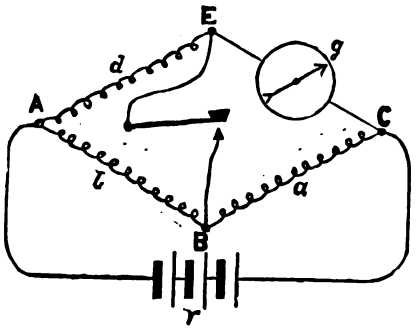


FIG. 1.

inserted between the points E and B, so that by its depression these points can be connected together.

First let us suppose the key to be up, and the points consequently disconnected. The current C, flowing through the galvanometer, will then be

$$C_1 = \frac{E}{r + \frac{(a+b)(d+g)}{a+b+d+g}} \times \frac{a+b}{a+b+d+g}$$

$$= \frac{E(a+b)}{r(a+b+d+g) + (a+b)(d+g)}.$$

Next the key is supposed depressed and the resistances

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adjusted till the galvanometer deflection is the same, and ultimately the equations show $g = \frac{a\,d}{b}$. Then the practical way of connecting for the test is shown by Fig. 2, and so on.

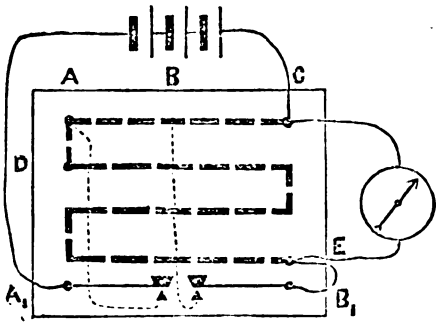

FIG. 2.

In this case the equational reasoning commences with the current through the galvanometer. We suggest that the student should give in his note book the manner in which he obtains this value of C_1. In a note book before us the student has done this as follows:—

Let current at A = C.

$$\text{By Ohm's law } C = \frac{\text{E.M.F.}}{\text{Total resistance}}.$$

Resistance = battery resistance and joint resistance of conductors.

Let r = battery resistance.

$x = d + g$.

$y = b + a$.

$$\text{Joint resistance of } x, y = \frac{x\,y}{x + y}.$$

$$\therefore\ C = \frac{E}{r + \frac{x\,y}{x + y}}.$$

Using the constituent parts in place of x and y, we have

$$C = \frac{E}{r + \frac{(d + g)(b + a)}{d + g + b + a}}.$$

Suppose C divided into $a + b + d + g$ parts, then, if these parts $a + b$ go through g, and $d + g$ go through the other conductor, according to the law that the currents are inversely as the resistances—that is, the current through g is $\frac{a + b}{a + b + d + g}$ of the whole; but, as we have seen, the whole current

$$C = \frac{E}{r + \frac{(d + g)(b + a)}{a + b + d + g}}.$$

$$\therefore\ C_1 \text{ (through } g) = \frac{E}{r + \frac{(d + g)(b + a)}{a + b + d + g}} \times \frac{a + b}{a + b + d + g},$$

which is the starting equation of Mr. Kempe.

This digression is simply in the interest of students. Nothing but practice will make them perfect, and as many of them have but an imperfect acquaintance with algebra, such practice is beneficial.

Mr. Kempe treats of the internal resistance of batteries, of E.M.F., of the theory and uses of Wheatstone's (Christie's) bridge, and so on to the testing of faults, and the delicate work in connection with cables, showing throughout his complete knowledge of the subject, and his ability to put that knowledge into such a shape as must commend the book to everybody interested in these subjects. Our space is too limited to call attention to the whole of the contents of the book, or to criticise the various methods discussed. This, however, is unnecessary, when we emphasise our conviction that the book is by far the best treatise on the subject, and that it should be in the hands of every student, and especially of every student connected with testing in cable work. The illustrations are generally clear, whilst the type and arrangement are far better than in the old edition.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The first of the forthcoming winter meetings of this society was held at the Institute of Civil Engineers on the 10th inst., when a paper was read by Mr. JOHN ALEXANDER LUND "On the System of Synchronising Clocks Adopted in London and Elsewhere." Professor FOSTER, the president, occupied the chair. There was a good attendance. The minutes of the last ordinary meeting and of the two extraordinary meetings held in Paris during the Exhibition having been read, Mr. Lund commenced by disclaiming any thought of introducing electrical novelties to the notice of this society; all that he had done, and those who had worked with him, was to apply the known properties of electricity to one of the practical demands of daily life, namely, the maintenance of a system of correct time keeping for any number of private or public clocks by means of an electric current. The synchronising of clocks was by no means a modern idea; indeed, one of the very first uses to which it was designed to apply electricity was the regulating of timepieces, but the difficulties which then presented themselves caused the attempt to be abandoned. The several modes of regulation that had been subsequently tried were then explained. The escapement acted upon directly by the current was the first idea; another was to make the current act upon the escapement through the pendulum; in a third the pendulum itself was controlled by the current; an electro-magnet acting upon the motion works had also been used; as had also a current controlling the hands. These modes might again be classified under the heads of clocks worked by the electric current, clocks controlled by it, and clocks set to time by it. None of these modes of synchronising timepieces, however, made any permanent impression on public good opinion down to within about four years ago, not more than a dozen clocks ever having been embraced by any one of the systems devised. The reasons were obvious. The clocks had to be of similar make, the electrical apparatus attached was expensive, and even then no two clocks would go exactly alike. Mr. Lund hit upon the simpler expedient of setting the clocks right when they were wrong; and under the system managed by him this was done every hour throughout the twenty-four. The essential requisites for a popular system were—first, that the clocks must go independently of the current, as it would never do to let the clocks stop because of current failing; secondly, it must be adaptable to any pattern of clock, for owners of clocks would not be at the expense of purchasing a special pattern; thirdly, it must correct clock errors, because, as already stated, no two clocks would maintain exactly the same rate. The method devised by Mr. Lund possessed these merits. It consisted of an ordinary electro-magnet, a pair of levers, and finger and thumb, by means of which the minute hand was gripped through a slot in the dial, at fixed intervals, and set to the right time—pushing the hand back if too fast, or forward if too slow. Assuming that this is done every hour, and that the clock does not vary more than twenty-four minutes in the day, such a mode of keeping correct time may be carried out cheaply, durably, and efficiently. Turning, then, to the actual system employed for maintaining a number of clocks under control in this manner, Mr. Lund explained that it was primarily worked by means of a standard clock on his establishment, a duplicate also being in readiness to automatically discharge the duty if one should accidentally run down. This standard is corrected automatically by a chronograph in communication with Greenwich, a dot being marked on its dial indicating the extent of error. There is also a fault-finder, as he called it, connected electrically with the standard and the external circuit, indicating by means of bell and dial when and which circuit failed. To this, again, was connected the distributor, each circuit having its own battery and line wire, embracing a convenient circle of clocks in localities mapped out according to needs. In this way some 15 main circuits, embracing over 400 clocks, were now in operation in all parts of London, from the extreme south of Kennington to Hoxton in the north, and from the West End to the docks in the east. It had also been extended to outside places, and Mr. Lund was understood to say that a clock at Dumbarton was so regulated from London. The time current had, moreover, been utilised for other purposes, such as that which may be seen at the London Stock Exchange, where a flashing disc tells the time every hour in a way that cannot be mistaken, and concerning which, in the case of "time bargains," there can arise no dispute. An electrical time ball was also used in some places, its peculiarity being that it required winding only once in six months, the fall of it causing it to ascend, and the completion of the ascent causing the clockwork to stop. Again, the signal had been used to ring bells in workshops, and to do this at fixed times on certain days, omitting those days and hours

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during which the workpeople are away—all of which, by an ingenious combination of clockwork and electricity, is automatically performed. In concluding, Mr. Lund acknowledged the services of previous labourers in the same field of usefulness who had rendered his own success possible by showing what difficulties were practically insurmountable and what alone remained to be overcome. He claimed that now for the first time we possessed a system of time regulation, and that London was the first and only city in Europe so provided.

Sir CHARLES BRIGHT spoke in high terms of the system of sychronising devised by Mr. R. L. Jones, and in operation at Liverpool. It had the advantage of continuous regulation, so that the exact time could be seen between the hours as well as at the hours.

Mr. STROH remarked that such a system involved the entire appropriation of the wire for time purposes, which, of course, increased the expense. He asked whether Mr. Lund had made any attempt to correct the clock tendency to error as well as to set it right?

Mr. COFFIN mentioned a clock at the Technological Institute to which he was attached in the United States, which not only sent correct time but regulated the clocks, preventing the jamming of the hands under the "finger and thumb" which he apprehended would happen in Mr Lund's method if the loss or gain was unnoticed, and allowed to increase. The clock mentioned, however, was only experimental and had been abandoned.

Mr. LUND in reply showed how the signalling wire was utilised for telephonic purposes, a wire leading from the Institute to Pall Mall, and embracing twelve clocks, being spoken through quite intelligibly. He also, in reply to Sir C. Bright, insisted upon the impossibility of satisfactorily maintaining a system of constant synchronisation, in proof of which he mentioned that one of the foremost of the advocates of that system had abandoned it and adopted Mr. Lund's.

A hearty vote of thanks was then conveyed to Mr. Lund, who subsequently showed his collection of clocks and apparatus in detail to many of the audience who remained behind.

The next meeting of the society was announced for the 24th instant, when reports of the Paris Electrical Exhibition by Sir C. Bright and Professor Hughes will be read.

THE PHYSICAL SOCIETY.—Nov. 12.

The first meeting of the Physical Society for the winter session was held on Saturday, November 12; Professor Fuller, vice-president, in the chair.

Mr. W. D. Niven was elected a member.

Mr. LEWIS WRIGHT then read a paper "On Some Spirals Observed in Crystals, illustrating the Relation of their Optic Axes." After remarking that the relation of the axes in uni-axial and bi-axial crystals had always been an interesting subject, he observed that if we took any uni-axial, and a single axis of any bi-axial, which had little or no axial dispersion, and polarised and analysed each circularly, we ultimately got similar phenomena. This is illustrated by calcite and a single axis of sugar, each giving, when thus treated, unbroken circular rings. From this it might be hastily inferred that a single axis of a bi-axial resembled in character the axis of a uni-axial, but this was not the view of those who framed the theory of double refraction in crystals. Fresnel finally framed the conception of three elasticities in three rectangular directions. If all were equal there was no double refraction; if only two were equal there was a single optic axis in the direction of the third; and if all were unequal there were two optic axes. According to this theory the axis of the calcite did *not* resemble in character a single axis of the sugar or other bi-axial, but was a limiting case in which *both* such axes coincided. This was illustrated by the beautiful experiment of Professor Mitscherlich, applying heat to a crystal of selenite, and thereby altering the respective elasticities. The two axes gradually approached until they coincided and the crystal became uni-axial, after which, on heating the crystal still more, the axis re-opened in a direction at right angles to the former, thus proving Fresnel's theory. Sir George Airy had illustrated the point that the axis of a uni-axial did retain or still embraced within itself in some visible form characteristics of the two axes thus brought into coincidence. This was done by his discovery of the double spiral in quartz. Uni-axial calcite showed a double spiral, and bi-axial gave a single spiral. Mr. Wright repeated Professor Mitscherlich's experiment with this additional method of analysis, the spirals being first shown perpendicularly arranged above each other. Gradually they approached until they resembled those of the calcite, and finally opened out again horizontally. All through there was a double spiral, and a single one could only be got by separating a single axis. The fluid would represent the axial properties of the quartz, and the crystal the other properties, and the two ought to give similar spirals. In fact, the fluid should replace the quartz successfully in all these experiments. By means of a column of oil of lemon 200 millimetres in length, and crystals of calcite, sugar, topaz, and nitre, Mr. Wright showed this to be the case. Finally, he demonstrated that the same phenomena held good through all the ordinary analogies with, or artificial substitutes for, natural crystals; the figures being produced with a circular chilled glass, in parallel light, and also with an artificial uni-axial crystal made of crossed mica films, after Norremberg, and an artificial quartz made of super-imposed mica films, after Reusch, in convergent light. All the figures were projected by the electric camera to a size eight feet in diameter. All Mr. Wright's experiments went to illustrate the truth of Fresnel's theory.

Mr. C. V. BOYS then read a paper "On the Prevention of the Bursting of Water Pipes." Mr. Powell had proposed the use of pipes of elliptical or other round section, and Mr. Mangnall, of Manchester, had independently hit on the same idea. Such a pipe would become rounder in section when the water froze and expanded. A round pipe tends to become thinner at its weak parts on expanding under the pressure. With an elliptical pipe the force required to alter the shape of its section is greater as the section is more circular, therefore the effect produced by a change of shape at any place makes that place stronger. A round pipe is in a state of unstable, and an elliptical pipe in a state of statile equilibrium, and changes its form uniformly from end to end. Hence if a portion only of such a pipe is exposed to the cold, the whole is effective, and it will require a proportionally greater number of frosts to make the pipe round. Inspection would show if the pipes were becoming round, and then they could be squeezed back to their original shape. Mr. Boys had demonstrated these inferences by experiment with Mr. Powell. Messrs. Powell, Rigby and Co., of Piccadilly made these pipes.

Mr. J. MACFARLANE GRAY drew attention to some apparent discrepancies in the constants employed by Regnault in his work on the physical properties of steam.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES NOV. 16.		BUSINESS DONE WEEK ENDING NOV. 16. Highest.	Lowest.
Anglo-American	53,	53¼	52¾	52¼
Do. Preferred	82½,	83¼	83¼	81¼
Do. Deferred	23½,	24¼	24	23¼
Brazil Submarine	11½,	11¾	11¾	11¼
Cuba	9¼,	10	—	—
Do. Preference	16,	17	—	—
Direct Spanish	5,	¼	—	—
Do. Preference	14½,	15¼	15	15
Direct United States Cable	10¾,	11¼	11¼	11
Eastern Telegraph	10¾,	10¾	10¾	10¼
Do. 6 per Cent. Preference	12¾,	13¼	13	13
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	11,	11¼	11¼	11
German Union	10½,	11	10¾	10¾
Globe Telegraph and Trust Company.	6¼,	6¾	6 11-16	6½
Do. Preference	12¼,	12¾	12¾	12¼
Great Northern	12,	12¼	12¼	12¼
Indo-European	27½,	28¼	—	—
Mediterranean Extension	2¾,	3	—	—
Do. Preference	9½,	10	—	—
Reuter's	12,	12½	12¼	12½
Submarine	290,	300	293	293
West India and Panama	1¾,	2	1 15-16	1¾
Do. 1st Preference	7¾,	8	7¾	7¾
Western Brazilian	7½,	7¾	7¼	6¾
West. Union 7 per Cent. 1st Mortgage	123,	128	125	125
Do. 6 per Cent. Sterling Bonds	104,	107	106	106

TELEPHONES.

Telephone Construc. & Maintenance	¾,	1¼	1 1-16	1 1-16
Oriental	⅛,	¼	¼	7-16

ELECTRIC LIGHT.

Electric Light and Power	1½,	¼	1¾	¾
Anglo-American Brush	7¾,	8¼	8¼	8¼

TRAFFIC RECEIPTS FOR OCTOBER, 1881.

COMPANIES.	Oct., 1881.	Oct., 1880.	Increase.	Decrease.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	2,063	1,821	242	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,164	29,061	2,103	—
Eastern Telegraph Company	48,872	45,570	3,302	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

768. IMPROVEMENTS IN CONNECTING THE ENDS OF THE CARBON TO THE CONDUCTING WIRES IN ELECTRIC LAMPS, *E. G. Brewer.*—*23rd February*, 1881.—(*A communication from T. A. Edison.*) 6*d.*

This invention is intended as a substitute for the clamps usually employed to fasten the wires to the carbon, and consists in uniting the wires and carbon and then electro-plating the union.

843. IMPROVEMENTS IN CARDS AND MAGNETIC NEEDLES FOR MARINERS' COMPASSES, *H. J. Haddan.*—*28th February*, 1881.—(*A communication from J. Lewis and F. A. Brown.*) 6*d.*

The first part of the invention relates to the construction of the compass needle so as to taper at its poles, being rectangular between them and slotted in its body between the poles and its pivotal bearing, this being stated to make it very sensitive. The second part relates to the prevention of local attractions by neighbouring metal. This is done by combining with the needle and the card a series of U-magnets, arranged at proper distances apart with their axes in lines radiating from the centre of the card, and with the north pole of each of such magnets towards the south pole of the needle.

1087. ROTARY HAWSE PIPE FOR KEEPING SUBMARINE CABLES CLEAR OF THE CABLE CHAINS WHEN THE SHIP IS SWINGING, *T. Cockshott and H. M. Goodman.*—*14th March*, 1881.—(*Not proceeded with.*) 4*d.*

This consists of two rotating hawse pipes contained in one casting, and carried by friction rollers or other bearings in flanges or framing fixed to the ship's bow. The pipes consist of a large one concentric with the rotating casting and intended for the ship's cable, and the smaller one at one side for the passage of telegraph cables.

1257. LAYING TELEGRAPH WIRES, *S. Pitt.*—*22nd March*, 1881.—(*A communication from W. B. Espeut.*) 6*d.*

This invention relates to the laying of underground wires. The inventor uses pipes made of porcelain ware, connected by thimbles to allow the end of one pipe to touch the end of the other, the two ends being cemented by white lead; these thimbles may be of iron or ware. Where it is required to lay several wires the pipes are perforated longitudinally, so that the walls of each division constitute an insulator for the wire laid therein. When it is required to lead off a wire to a station, the inventor fixes a L piece into the pipe, through which the wire can be led. If the traffic be heavy where the wires are to be laid, an iron tube lined with porcelain is made use of, such lining being formed in longitudinal compartments.

1393. IMPROVEMENTS IN ELECTRIC DRILLS, *J. H. Thomson*, *29th March*, 1881.—(*Not proceeded with.*) 2*d.*

This relates to portable drilling machines operated by electricity, and made for handwork.

1422. PRODUCTION OF ELECTRIC LIGHT, *W. Crookes.*—*31st March*, 1881. 4*d.*

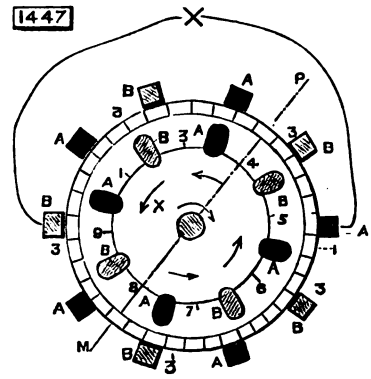
This relates to the removal from the carbons as used by Swan, Edison, Maxim, Lane-Fox, &c., of the impurities by means of acids, &c., and thus obtaining pure cellulose.

1442. ELECTRIC BATTERIES, *F. Rola de Wolski.*—*1st April*, 1881.—(*Not proceeded with.*) 2*d.*

The object of this invention is to reduce the internal resistance of cells by limiting the electric action to the opposing surfaces of the electrodes, the reverse surface of either or both these being rendered inactive by coating with an insulator or otherwise.

1447. IMPROVEMENTS IN DYNAMO-ELECTRIC OR MAGNETO-ELECTRIC AND ELECTRO-DYNAMIC MACHINES, *C. W. Siemens.*—*1st April*, 1881.—(*A communication from Siemens and Halske.*) 6*d.*

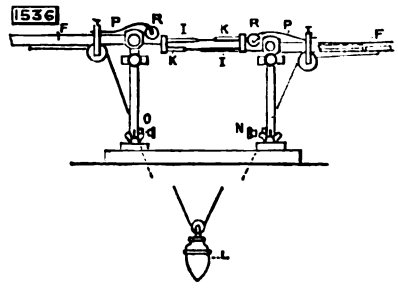
This invention refers to a machine in which separate electrical impulses are generated immediately after one another at different parts, and combined together in one continuous current.



The diagram illustrates the action of the machine. The outer squares A B represent ten stationary fields of alternating polarity, and the inner ellipses A B represent the eight coils that revolve through them. The divided circle between these represents the commutator, having its forty plates arranged in five groups, each containing eight plates. The numbers between the ellipses indicate the wires that lead from the connecting wire of each pair of adjoining coils to the rings, and thence to the commutator plates. Thus, wire 1 is connected through its ring with all the five commutator plates marked 3, wire 2 with all five plates marked 8, and so on. Arrows + and — indicate the commutator brushes. All coils which are approaching fields marked with the same letters A to A and B to B, have currents set up in them in one direction, indicated by arrows X, and all coils approaching fields marked by different letters A to B, or B to A, have currents set up in the opposite direction. There will always, therefore, be a diametrically dividing line, such as P M, towards one end of which there is an accumulation of positive and towards the other of negative electricity. (This machine was fully described and illustrated in *The Electrician*, Vol. VII., p. 58.)

1536. ELECTRIC LAMPS, *J. L. A. Dupont-Auberville.*—*8th April*, 1881.—(*A communication from V. Delaye.*) 6*d.*

In this lamp the carbon-holders F are placed in upright supports, and a horizontal motion is given the carbons by the weight L. The arc is formed between the carbons I, while the abutments K —made of some refractory material—become



incandescent, thus increasing the power of the light and causing it to resemble sunlight. The current enters by posts N and O, and is passed through the carbons by plates P provided with friction rollers R. Great steadiness is claimed for this light.

243,746. DYNAMO-ELECTRIC MACHINE, *James J. Wood, Brooklyn, assignor to the Fuller Electrical Company, New York, N.Y.*—*Filed April 7th*, 1881.

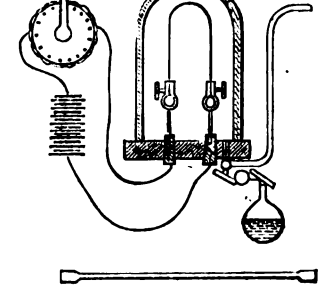
Brief.—The circuits from the armature sections are taken separately to the lights or other working devices, then, by a common return conductor, back through the field magnets to the opposite ends of the armature sections. *Claim.*—(1) An electric lighting apparatus consisting of a magneto-electric machine having an armature formed with a series of two or more distinct coils or groups of coils, and a commutator having corresponding sections, with collecting and transmitting springs bearing thereon, in combination with a series of two or more lamps, each connected on one side with one of the springs on one side of the commutator, and all connected on the opposite side to one common or main conductor connected with the several springs at the opposite side of the commutator, substantially as and for the purpose herein set forth. (2) An electric lighting apparatus consisting of a dynamo-electric generator having an armature formed with two or more distinct coils or sections, and a commutator with corresponding sections connected therewith, with collecting and transmitting springs bearing thereon and mutually insulated on one side of the commutator, in combination with a series of two or more lamps, each connected independently on one side with one of the said insulated springs, and all connected at the opposite side to the coils of the field magnets, which, in turn, connect to the opposite side of the commutator, substantially as and for the purpose herein shown and described.

243,765. ELECTRO-MAGNETIC MOTOR, *Moses G. Farmer, Newport, R.I.*—*Filed March 25th*, 1881.

Brief.—To avoid the production of induced currents the ends of the helix wires are connected at the moment when the current is cut off from the helices, the connection being so made that the currents of induction pass in opposite directions and neutralise each other. *Claim.*—(1) The hereinbefore described method of neutralising or destroying the induced current generated in the helix of an electro-magnet upon the cessation of the primary current traversing the same, which consists in uniting with each other the respective opposing terminals of the two sections of the divided helix, and thereby forming a closed circuit immediately upon the disconnection of the generator. (2) The combination, substantially as hereinbefore set forth, of two helices included in the same current and acting in unison upon the same core or armature, a commutator automatically operated by the movement of said core or armature, and circuit connections, substantially such as described, whereby the connections of the terminals of the respective helices are reversed, so that a current is made to traverse said helices alternately in the same and in an opposite direction with reference to each other. (3) The combination, substantially as hereinbefore set forth, of a movable core or armature, two helices or coils arranged to act simultaneously upon said core or armature to impel it in a given direction, a commutator automatically operated by the movement of said core or armature, and circuit connections, substantially such as described, from the commutator to the helices, whereby the opposing or like terminals of said coils are united at the termination of the stroke to form a closed circuit before the disconnection of the generator.

247,083. PROCESS OF MANUFACTURING CARBONS *Hiram S. Maxim, Brooklyn, assignor to the United States Electric Lighting Company, New York, N.Y.*—*Filed 6th April*, 1881.

Claim.—(1) The process of manufacturing carbon conductors for electric lamps, which consists in cutting the blanks from fibrous material,



carbonising the same, bending the carbonised strips into the desired shape, and then electrically heating them for giving them a permanent set, as described. (2) The method herein described of fixing a carbon strip in any form to which it may have been bent, by subjecting the same while bent to the action of an electric current in an atmosphere of carbonaceous gas or vapour, substantially as set forth.

246,407. MANUFACTURE OF ELECTRICAL CONDUCTORS, *Thomas T. M'Tighe, Pittsburg, Pa.*—*Filed July 13th*, 1881.

Claim.—The method of manufacturing insulated and protected electrical conductors, consisting in first producing longitudinally grooved or corrugated strips of lead, then inserting insulated conductors in the grooves, and finally subjecting the whole to pressure, substantially as described. (2) The method of manufacturing insulated and protected electrical conductors, as described.

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INTERNATIONAL ELECTRIC EXHIBITION.

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This Company will undertake to supply receiving instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

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By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

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as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

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ESTABLISHED IN 1868.

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All communications on the subject to be addressed to Mr. H. JACQUES, Surveyor to the Vestry, Vestry Hall, St. Martin's-place, W.C.

J. DANGERFIELD, Clerk to the Vestry.

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N.B.—Watches can be converted to this plan.

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All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

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Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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The Corporation are willing to receive applications for licences or concessions for defined districts, counties, or towns in the United Kingdom.
By the Brush system any number of lights, from 1 to 40, each of 2,000 candle power, or any number from 1 to 12, each of 6,000 candle power, or a single light of 50,000 or more candle power, can be produced from one dynamo machine. The connecting wires may be extended over circuits of many miles, and it is claimed that economy, constancy, and simplicity are secured at a less cost than by any other system.
The Corporation is also prepared to supply for domestic lighting, incandescent lamps of 10-candle power and upwards, manufactured with the newest improvements, under the "Lane-Fox" system. These lights are suitable for private houses, business offices, clubs, hotels, &c.
Concessions for the colonies and for foreign countries of the valuable patent rights under both of these systems, including methods of manufacture, regulation, and distribution, can be negotiated with the Corporation.
All inquiries to be addressed to the Secretary, at the offices, Belvedere-road, Lambeth, S.E.

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ELECTRIC LIGHT ENGINEERS
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The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.
The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.
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SLIP

THE TELEPHONE IN VIENNA.—We hear that underground telephone lines are being laid in Vienna in leaden tubes.

ELECTRIC RAILWAY FOR LYONS.—A project is on foot for establishing an electric railway in this town of Southern France.

BUENOS AYRES ELECTRIC LIGHT COMPANY.—The formation of this company is announced, with a capital of £100,000.

ELECTRIC LIGHT AT HOVE NEAR BRIGHTON.—Hove is to be lit up by the Brush system. Messrs. Hammond and Co. have the contract.

SS. "FARADAY."—This cable ship was obliged to return to London towards the latter end of last week, in charge of a tug, owing to the break-down of one of her engines.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ended 4th and 11th November amounted to £3,705 and £3,695 respectively.

ELECTRIC LIGHT COMPANY FOR BRISTOL.—A proposal to start an electric light and power company to supply Bristol and the West of England is said to have been taken up in that city.

TELEGRAPHS INTERRUPTED.—During the heavy gale of Monday night and Tuesday telegraphic communication between Chester and Ireland and Chester and Scotland was interrupted.

GOVERNMENT CABLE DEPOT.—Tenders were to have been sent in to H.M. Commissioners of Works and Public Buildings last Monday for the erection of a telegraph cable depôt at Woolwich.

ELECTRIC LIGHT FOR BOURNEMOUTH.—It is stated that the Local Board are thinking of introducing the electric light into the town, and have communicated with various firms on the subject.

THE SIEMENS TRAMWAY IN PARIS.—It is stated that Messrs. Siemens' electrical tramway has conveyed during the time in which the Electrical Exhibition has been open no less than 84,000 passengers.

ELECTRICAL DIRECTORY OF ENGLAND FOR 1882.—In our notice of the above work, which is to be brought out by Mr. J. A. Berly, the price should have been stated in our last issue as 3s. 6d., and not 2s. 6d.

NEW BOOK.—We learn that Mr. William T. Emmott, of Blackfriars-street, Manchester, will shortly issue a work by Mr. Urquhart, C.E., on electro-motors and the transmission of power by means of electricity.

THE TELEPHONE IN PARIS.—The President of the French Republic has had his rooms in the Elysée placed in telephonic connection with the Opera House, the Theatre Français, and the Odéon Theatre. This is said to be the outcome of his visit to the Electrical Exhibition.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th November amounted to £2,141, as compared with £1,278 in the corresponding period of 1880. The August receipts, estimated at £3,427, realised £3,467.

THE TELEGRAPH IN THE TRANSVAAL.—The Eastern and South African Telegraph Company notify that their telegraph offices at Pretoria, Standerton, and Heidelburg have been closed by order of the Volksraad; and, in fact, telegraphic communication with the interior of the Transvaal has practically ceased.

CROSSING THE CHANNEL IN AN ELECTRIC BOAT.—It is said that M. Tellier is having a small boat constructed of about 5·50 metres length, which will be impelled by means of an electric motor, and in which he intends to endeavour to cross the Channel between Boulogne and Folkestone. He will be accompanied by a Lieutenant Larade.

POST OFFICE TELEGRAPHS.—Notice has been given that an open competition for admission to the Post Office (Male) School of Telegraphy (age 14—18) will be held in London on the 19th of December. Further particulars and the necessary form of application can be had on application to the Secretary, Civil Service Commission, London, S.W.

INTERNATIONAL ELECTRICAL EXHIBITION AT PARIS.—It is stated that the net profits of the Electrical Exhibition amount to £16,000; and with this sum it is proposed, in accordance with the decree authorising the holding of the exhibition, to found a laboratory for electrical experiments, which, within certain limits, will be open to the public.

ELECTRIC LIGHT IN COAL MINES.—The electric light has been introduced into the Maerdy Colliery in South Wales by the British Electric Light Company. At present, we believe, there are two arc lamps erected, these being, of course, close to the shaft leading to the pit's mouth. It is probable, however, that incandescent lights will soon be fixed in other parts of the pit.

QUICK WORK.—On the night of Monday week Messrs. Hammond and Co. undertook the work of lighting the roads of Worksop by means of the Brush light, on the occasion of the Prince of Wales's visit to the Duke of Portland at Welbeck, and although a special engine had to be provided, and nearly three miles of wire hung, the work was completed by the following Saturday night.

SS. "DACIA."—The "Dacia," laden with cable for America, passed Portland on Sunday afternoon at two o'clock, Mr. William Falconer King in charge. Later information says that the "Dacia" had to put into Plymouth on Monday at 3 p.m. on account of heavy weather at the mouth of the Channel. She continued her voyage, however, on Wednesday morning at daylight.

S.S. "SERVIA."—This magnificent vessel, belonging to the Cunard line, has recently arrived in the Mersey, and been handed over to her owners by the builders, Messrs. J. and G. Thomson, of the Clyde. As we have stated before, she is fitted with both Swan incandescent and the Siemens arc lamps, which are fed from a Siemens dynamo-machine, driven by one of Brotherhood's three-cylinder engines.

THE TELEPHONE AND THE PULPIT.—Some time since we noticed that an invalid member of a Scotch Church had the service conveyed to him by means of a telephone line from the pulpit to his bedside. We now hear that in the West Free Church, Dundee, which has just been renovated, a telephone line has been established from the pulpit to the bedside of a bedridden member of the congregation.

ACTION OF COLD ON THE VOLTAIC ARC.—M. Tommasi finds that surrounding the electric arc by tubes filled with cold water produces a great effect upon it, the luminous power being very much weakened, and the arc itself so much affected that it is possible to blow it out by a puff. The two poles of a magnetic bar also are found to influence it considerably. M. Tommasi used Bunsen cells as a generator.

ELECTRIC LIGHT FOR IRONWORKS.—At a recent meeting of ironmasters held at Middlesbro' the question of the advisability of forming a company to supply electric lights on the Brush system to the various workshops in the neigh-

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bourhood was considered. No conclusion was, however, arrived at, the ironmasters preferring to await the further development of electric lighting before entering on any scheme.

ELECTRIC LIGHT FOR RAILWAY STATIONS.—The directors of the Midland Railway Company are considering a scheme for lighting the entire length of the Erewash Valley stations, junctions, branches, and sidings, by electricity. It is proposed to light as far as Alfreton by one engine, fixed at Chesterfield, and as far as Pye Bridge by another fixed at Nottingham. The stations on the above line are very close together.

OVERHEAD WIRES IN AMERICA.—The New York *Hour* of a recent date thus expresses itself:—"Chicago refuses to allow the Mutual Union Telegraph Company to erect additional poles in the streets of that city. The company will be forced to put its wires underground. Similar ordinances should be passed by every city, and not more than a year's time given to remove the present unsightly poles from our thoroughfares."

A YEAR'S INDIAN TELEGRAMS.—It is stated that the number of messages sent by the Indo-European and Red Sea routes during the year 1880-81, exclusive of transit telegrams to India, was 65,582; from India, 76,341; total, 141,923. A large proportion was sent *viâ* Suez, namely, 104,780. The figures for the Indo-European routes are as follow:—*Viâ* Teheran, 32,853; *viâ* Turkey, 2,783; Persian Gulf, *viâ* Kurrachee, 1,507.

ELECTRIC LIGHT FOR TRAINS.—The new Pullman car train has arrived from the construction sheds at Derby, and it is expected it will begin running on the London, Brighton, and South Coast Railway on Thursday next, though we believe the date is not definitely settled. Both Swan's and Edison's incandescent lamps are to be used, with the Faure battery to supply the necessary electricity. It is stated that the cells to be employed will weigh two tons.

ELECTRIC LIGHTING.—Amongst the notices of intention to apply to Parliament in the next Session for particular powers, we notice that Messrs. Siemens Bros., the Brush Company, British Electric Light Company, Electric Light and Power Company, and others, intend to apply for powers to break up streets, &c., and to set up apparatus for producing the electric light in streets, houses, mines, &c., and also to supply power to manufactories, &c.

ELECTRICAL STEERING GEAR.—Dr. A. Foucaut, late of the French navy, writes to *La Lumière Electrique*, with reference to the statement that an English ship had been steered by the compass actuated by electricity, to say that he patented an invention for doing the same thing so long ago as 1870. The patent was taken out in France and in America, the No. being 105,562 (1870). He says that his compass, which gave warning of any deviation of the ship from its course, was exhibited at the Havre International Exhibition, and there obtained a silver medal. We presume Dr. Foucaut is referring to the invention of Mr. King, of Edinburgh, which has recently been noticed in our columns.

TRANSMISSION OF SEPARATE SOUNDS ON ONE WIRE.—M. Maiche has found by experiment that sounds of different characters produced from two separate sources can be sent simultaneously on one wire and received separately. He used at the receiving station two telephones of different resistances, and at the transmitting station caused a musical box to be set going on a microphone of small resistance, whilst an induction telephone transmitter was spoken into at the same time. The musical sounds were reproduced in the telephone which had the least resistance, and the vocal sounds in the other, so that with the two telephones to the ears the music could be heard by one ear and the speech by the other.

"HEALTH PRESERVATION."—This is the title of a little work by Mr. Richard Herring, the second edition of which has just been issued. The book is a collection of prescriptions for the ordinary ailments of mankind, arranged in order and with a few practical remarks upon each. Mr. Herring introduces us to a new analogy for the liver, that plague of most of us, which he likens to a "secondary battery storing and supplying the heat and energy which is created by the primary battery of the stomach," and the action of which he begs us to keep unimpeded by carelessness or neglect. Mr. Herring's book is of handy size, well printed, short, practical, and to the point. As to the prescriptions, they have been well spoken of by others, and we intend trying them ourselves.

UNDERGROUND TELEGRAPHS IN FRANCE.—It is announced that the work of laying the underground cables between Paris and Lyons is approaching completion. Some difficulty has lately been experienced with the workmen, however, employed on the Lissieux portion in the Rhone Department, who want an addition to their pay of fifteen centimes per hour. It is to be sincerely hoped, as our contemporary, *La Lumière Electrique*, says, that this work will be finished before the winter sets in, as, according to the predictions from the Montsouris Observatory, there are to be three months of extreme cold in France, accompanied by heavy falls of snow. If the lines are underground before the snowfalls come, the French Telegraph Department may snap their fingers at storms, be they never so heavy.

TELEGRAPHS IN JAPAN.—There were in Japan at the beginning of last year 3,929 miles of telegraph line, with 9,345 miles of wire. The total number of telegrams sent during the year was 1,272,756, of which 96 per cent. were Japanese, international messages numbering only 22,695. A telegraph school has been founded for the instruction of young Japanese in telegraph work, where they also learn to speak and write English and French. In 1880 there were 112 offices open for general work, and 70 others connected with the State departments, the railways, and police; 53 remained open day and night. There were 348 Morse instruments in use, 26 single needle instruments, and 29 Bell telephones. The total receipts for the year amounted to £108,323, and the expenses to £101,674. The Japanese telegraph lines date from 1871.

ELECTRIC DISCHARGE IN RAREFIED GASES.—Herr Hellman has constructed a discharge tube formed of a very short cylinder, containing the platinum cathode, and communicating by one of its ends with a tube one centimetre in diameter, at the end of which was the anode. This tube, which was curved at a right angle, ended in the desicating jar of a pneumatic pump. On the air being rarefied, and the discharge allowed to pass, the halo of the anode extended in the tube as far as the desicating jar, thus reaching a length of 50 centimetres. No phosphorescent light was seen in the curve of the tube, even in complete darkness, whilst the sides of the glass surrounding the cathode were covered with a green phosphorescence. When the poles were reversed, the light no longer expanded in the tube, but the sides round the electrode showed a green phosphorescence. These experiments are described in a recent number of *Wiedemann's Annalen*.

THE TELEPHONE ON BOARD SHIP.—The telephone has

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been introduced on board the screw steamer "Gloucester City," a vessel of 2,150 tons gross register, which was launched a few weeks ago by Messrs. Richardson, Duck, and Co., of Stockton-on-Tees, and is now taking in her engines and being made ready for sea at Hartlepool. The apparatus used is one of Hunning's micro-telephone transmitters and Harrison, Cox-Walker, and Co.'s (Darlington) receiver. The wires extend from the captain's berth to the chart house, and there is no difficulty in gaining the ear of the officer on watch posted on the bridge; and the captain, if in the chart house, can by the same means communicate with the ship's company. The cost of the apparatus complete is £17 10s. The same appliances were lately provided on board the "Brooklyn City," a sister ship to the above. The "Gloucester City" belongs to Messrs. Charles Hill and Sons, of Bristol and Cardiff, and is designed chiefly for the North Atlantic trade.

Paris Exhibition.—The Closing Day.—The International Exhibition seems to have been turned into a kind of pandemonium during the last hour of its existence, if we may judge from the following extract from a telegram to a daily contemporary, which says:—"An immense crowd besieged the Palais de l'Industrie yesterday (November 20) admission being free. In the evening, when the exhibition was illuminated for the last time, there was scarcely standing room either in the main hall or the galleries, most of the visitors being of the artisan class out for their weekly holiday. The usual custom of closing exhibitions by a general letting loose of all the noisy elements contained in the show was observed on this occasion with an almost deafening effect. Shortly before eleven the whistles of all the steam engines and every electric bell in the building were set going, making such an unharmonious din as was certainly never heard before. Fortunately for the hearing powers of the audience it only lasted a few minutes, and had the desired effect of clearing the palace of its thousands of visitors."

Action of Sulphuric Acid on Zinc.—A note on the action of sulphuric acid on zinc and tin was read before the Chemical Society on the 3rd inst. by M. M. P. Muir and C. E. Robbs. The authors find that a strong sulphuric acid $7\,H_2\,S\,O_4 + 2\,H_2\,O$ exerts no action on zinc until a high temperature is reached, when $S\,O_2$ is evolved and some sulphur separates; more dilute acid (7 : 4) acts similarly with acid still more dilute 1 : 1, no $S\,O_2$ is produced, but $H_2\,S$ is evolved with the separation of sulphur; with weaker acids the action begins at a lower temperature, and hydrogen is the chief product of the reaction. Traces of sulphuretted hydrogen also come off, but no $S\,O_2$ and no S^1. The action of strong sulphuric on tin at ordinary temperatures is very slight, $S\,O_2$ being evolved and a little sulphur; as the temperature rises the action increases and $H_2\,S^1$ begins to appear; with acid 1 : 1 (molecules) $H_2\,S$ is evolved at a lower temperature, and at 120 deg. H, $H_2\,S^1$, and $S\,O_2$ and S are formed simultaneously, more dilute acids have but little action until the boiling point is reached, when H and $H_2\,S$ are evolved; with $H_2\,S\,O_4\,7\,H_2\,O$, H alone is formed.

A French Opinion of the Electric Light.—At one of the recent meetings of the International Meeting of Electricians, M. Vivarez, an engineer, gave it as his opinion that the electric light should as nearly as possible approach the light of the sun, and therefore that collections of lamps of a certain power will be used in the future, and not lamps on the incandescent principle (we presume M. Vivarez is speaking of outdoor illumination). He gives preference to the Jablochkoff and Werdermann systems, and is of opinion that the economy of the incandescent systems, in which the carbon, being in a vacuum, does not consume away, is not of such importance as is usually made out. The struggle between incandescent and arc lamps is a question of the motive power necessary for each, and from this point of view the arc lamp is the lamp of the future. We must not forget, M. Vivarez says, that the more light we have the more we want. He thinks that insurance companies should reduce their premiums on buildings which are lighted by the electric light, on account of the greater security thereby gained. He attributes the accidents that have happened with the incandescent systems to the fact that electricians will hide the conducting wires behind carpets, &c.

Underground Wires in Philadelphia.—We have from time to time referred to the laying of wires in underground trenches in Philadelphia. We now extract from our contemporary, *Engineering News*, of New York, the following description of the method of procedure:—"A trench is dug in the middle of the street, three feet nine inches in depth. The bottom and sides of the trench are lined with concrete. The tubes, two inches in diameter, are then put in place, five in a row, and four rows, one above the other. A composition of pitch and slag is then poured in, until the pipes are covered, after which the top is cemented with concrete. The ditch is then filled in and the earth rammed down. It is calculated that the twenty tubes will accommodate from 1,000 to 1,500 wires. A manhole is placed in each square, and the wires will be forced through after the tubes are all laid. The work is mostly done at night." Information from another source says:—"A test of the working of the new line on Market-street of the National Underground Electric Company was made recently at Philadelphia with three telegraphic instruments, two telephones, and an electric lamp. Solenoid wires, consisting of a single insulated wire wound about a similar straight wire, connected them. It is reported by the Philadelphia journals that the experiment proved successful."

Harold v. the India Rubber, Gutta Percha, and Telegraph Works Company.—In a previous action (see *Electrician*, Vol. VIII., No. 1., p. 3.), on an *ex parte* application Vice-Chancellor Hall granted an injunction to restrain the defendants from laying a submarine cable along the coasts of the United States of Columbia, Ecuador, and Peru from Panama to Callao, in breach of the concessions granted by the governments of those three countries respectively to Messrs. Frälick, Murphy, and Co., of Philadelphia. The present application was that this injunction should be continued. The plaintiff's case was that, under a power of attorney given by Frälick, Murphy, and Co. to Mr. T. W. Neill, dated the 21st of July, 1880, and a deed of agreement, dated July 29, 1880, to which Mr. Neill and Mr. Frälick, of the firm of Frälick, Murphy, and Co. were parties, the property in the three concessions had become vested in certain proportions in the plaintiff and three other gentlemen, Messrs. Frälick, Randall, and Garrison. The plaintiff alleged that, in breach of this assignment and the rights of the plaintiff and his associates under it, Messrs. Frälick, Murphy, and Co. had entered into a contract for the sale of the concessions to the Central and South American Telegraph Company, and that with this latter company the defendants had contracted to make and lay the cable. In April, 1881, an injunction was granted in an American court, on the application of Mr. Randall, to restrain Messrs. Frälick, Murphy, and Co. from making any grant or transfer of the concessions in breach of the rights of the plaintiff and his associates. On the part of the defendants it was argued that the effect of the two documents of July 21st and 29th was only in effect to associate the plaintiff and the other three gentle-

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men in the agency of Mr. Neill, and not to confer upon them any equitable interest in the concessions such as would enable the plaintiff to maintain the present action. A further objection was that an injunction against the defendants could not be granted in the absence of the American company.—The Vice-Chancellor, without deciding the second question, held that the two documents did not vest any equitable ownership in the concessions in the plaintiff, whatever might be his rights in respect of the profits of the undertaking, and he refused the motion.

Electric Light in the Antipodes.—We extract the following account of what is, we presume, the first display of the electric light in Fiji from the *Fiji Times* for Sept. 7, 1881, which has been kindly sent to us by a correspondent. It relates to the recent visit of the Royal Princes and the Fleet. The extract is as follows:—"In the evening his Excellency (Mr. Des Vœux) entertained the Vice-Admiral and a numerous company of officers and high officials at dinner. A great crowd of Fijians had assembled to entertain the Princes with native mekes, and as it was known that the electric light would be flashed from the 'Inconstant' during the evening a large concourse of Europeans also attended to enjoy the spectacle. The great novelty of the evening, the electric light, was flashed from the 'Inconstant,' and lighted up the scene with a soft yet powerful radiance as novel to the majority of the Europeans as it was to the amazed Fijians. The effect was surprisingly beautiful. Every frond of the palms on the hill-side, every leaf on the dark clump of the Wi trees in the background, every figure on the lawn came out into bold relief as the light flashed from point to point. The Fijians burst into yells of the wildest surprise and delighted amazement. For once the native character was fairly roused out of its peculiar phlegmatic *nil admirari* repose, and men who would not look twice at 'the monsters whose heads do grow beneath their shoulders' danced and shouted in all the abandon of uncontrolled and uncontrollable ecstasy. To the Europeans, the great majority of whom have never enjoyed an opportunity of witnessing this triumph of modern scientific research, the effect was none the less pleasing and gratifying, and although the expression of their pleasure was of course more subdued, it was every whit as hearty and genuine. The only regret expressed was that the night should have been a moonlight one, so that the effect was not so grand as it otherwise would have been. The peculiar density of the shadow caused by any object intercepting the rays of light was a source of constant remark and pleasant contemplation. The outline of every spray and leaf falling on the white field of a lady's dress embroidered it, as if by fairy hands, with flowers, foliage, and quaint designs, the ever changing variety of which afforded continual gratification. When flashed on the shipping in harbour, or houses in the town, every minute detail arrangement and feature was at once apparent, and during the hours the light was exhibited the eye never tired of feasting itself upon familiar scenes under this new and pleasing aspect. If from this cause alone the visit of the Princes will be long remembered in Levuka, and the thanks of its inhabitants are due to Lord Clanwilliam for the unqualified pleasure he has afforded them. It was not until long after the light had been extinguished that the parties of promenaders ceased to return to their homes, and the town once more resumed its wonted quietude."

King Kalakua and Edison.—Before leaving New York, King Kalakua called on Mr. Edison. He was accompanied on his visit by the Attorney-General of his island kingdom, Mr. Armstrong, and by an intimate friend residing in this city, whose acquaintance he made in Vienna. Punctually at nine o'clock in the evening his majesty alighted from the carriage of his friend in front of the Fifth-avenue mansion. He was introduced to Mr. Edison, who escorted him through the building, and by means of models, maps, drawings, and the 55 lamps in operation, explained the theory of the conversion of steam-power into electricity and the generation of light in the carbon loop. Escorting his distinguished visitor to the library, Mr. Edison first explained the science of the light, and then, by reference to maps of the district that his engineers are preparing for the experiment, the application of his system to the practical requirements of a city. The region to be lighted will require 22,000 lights, all of which are to be supplied from a central station in Pearl-street, where twelve engines of 185 horse-power are to be placed. Ten of these will be in constant operation, the other two being held in reserve to meet the emergencies of accident. The engines will be run at a rate of speed equal to that of a locomotive at sixty miles an hour, and a new feature of the system is that no belts are employed to transmit the power to the dynamo-electric generators, and the power is applied directly, avoiding the irregularity and vibration arising from the slipping of the belt which seems inseparable from the old practice. The mains consist of large iron pipes, in which the crescent-shaped positive and negative conductors are carried, being insulated from such by means of a non-conducting material with which the pipes are filled when in a pasty condition, induced by heat, but which hardens like a concrete pavement in the process of cooling. These mains in their passage through the streets are all connected with each other by means of ingenious connection boxes, the whole forming a subterranean network of electrical conductors comparable to the capillary circulation in the skin of an animal body. His Majesty listened with intense but almost silent interest, and examined the cross-sections of the electrical mains and the interior arrangement of the connection boxes with critical closeness, now and then asking a question in the purest English imaginable. He seemed particularly interested in the statement that after steam power had been transformed into electricity and carried to a great distance in that form it could again be converted into motive power by means of an electrical motor, and sold to customers for the purpose of running elevators or operating hoist-ways. His eyes lighted when he was told that one of the most profitable departments of the business of the company would be the sale of power to manufactories and business firms in quantities as small as a single-horse power, costing, under circumstances of ordinary use, not more than eight cents a day. From the library Mr. Edison led the way to the front parlour, brilliantly lighted. Pressing the toe of his shoe upon a knob projecting from the floor, every lamp was instantaneously extinguished and as suddenly blazed out again. The inventor next turned the stopcock of a single lamp among the group and extinguished it. The party then ascended to the upper floor, where more wonders were in store, and then descended two flights beneath the street level, where, in a low-ceiled vault, a small engine was operating with nearly absolute silence, a generator whose cylinder performed 1,200 revolutions per minute. After inspecting every detail, His Majesty took leave of the inventor, and repaired to his carriage. One of the points that appeared to impress him most was the steadiness of the light, and its freedom from vibration.—*New York Times.*

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SUBMARINE CABLES.

Under the above head an article appeared in *The Times* of the 19th of November, giving some account of the recent breaks that have occurred in the cables connecting this country with the continent, and the difficulties that are met with by the ships sent to repair them. It refers particularly to the obstacles encountered in the shape of fishing boats with their nets shot, the owners of which refuse to move them, the cable ships being thus "kept hovering about ignominiously between Lowestoft and the debatable ground, ready to dash in the moment the position is evacuated." Several letters have appeared in the same paper referring to this article, which we reproduce. They are as follow:—Sir James Anderson writes: "In your leading article on this subject of to-day's date (Nov. 19) the impression is conveyed that the Eastern Company's lines to India have all been interrupted, whereas the fact is that our duplicate lines, the whole way from Marseilles to India, have been and are in perfect working order. Our difficulty has been with our cables between Vigo, Lisbon, and Gibraltar, and these have been simply tortured and broken in no less than seven places, near the shore for the most part, by the violence of the storm. Five of these breaks have been repaired, and our communication is now intact by our Gibraltar route to Egypt and India, as well as by way of Marseilles. The public would, probably, never have heard of delay in the traffic to the East but for an unfortunate tempest which wrecked the land lines in France while the ship was repairing our Lisbon-Gibraltar cable. Fortunately, with that energy which is characteristic of the present telegraph administration in France, a wire by a more circuitous route was, as soon as possible, set aside for our traffic, and next day our Lisbon-Gibraltar cable was repaired. These interruptions to our system, occurring at a time when nine wires in the Channel were broken, thus destroying communication with India by the Indo-European Company's lines, caused some unusual delay, as compared with the customary rapidity with which telegrams pass between this country and India, and for two days the task of telegraphing between this country and the Continent and the East was both difficult and embarrassing. Unless some arrangement can be made by which telegraph cables shall be respected by fishermen and ships seeking anchorage we shall at all times be liable to these serious interruptions. The question of the neutrality of cables in time of war is often mooted; but it would be as much to the purpose if the protection of cables from perfectly preventable injury, and exemption from Custom House formalities and port dues to ships engaged in repairing submarine cables, were made the subject of international law. On a recent occasion two of our ships had to put to sea beyond Custom House jurisdiction in order to transfer cable from one ship to the other. One ship payed out cable while the other picked it up, and this delayed the repair of the cable for two days. Probably the time is not remote when this now indispensable system of communication between nations may be considered worthy the serious attention of the various Governments. Meanwhile both the shareholders in submarine cable property and the public are indebted to you for ventilating this important subject." Mr. J. R. France, M.S.T.E., writes from 158, Gresham-house, E.C., as follows:—"As a submarine telegraph engineer of many years' standing I fully confirm the statements in your leader of to-day as to the difficulties often occasioned unnecessarily in the Channel and North Sea by English and French fishermen during the drift-net seasons. Every endeavour to warn these fishermen by keeping the Board of Trade signals hoisted (these signals are visible from ten to twelve miles) is of little avail, smacks often sailing past you and shooting their nets in a direct line of the working ground, and, consequently, drifting on to the telegraph steamer (and buoys) which is helpless to get out of the way. I have been fouled with five drifts of nets at one time, sweeping away buoys and steamer, and so breaking afresh a cable that would otherwise have been repaired in the course of a few hours. The slightest forbearance on the part of the fishermen would lead to the work being speedily completed—say an average of sixty hours, and all obstruction out of their way. The fact of the sea beyond the jurisdiction of the marine league from the coast being no man's land destroys all hopes of redress, and it is only by international law that submarine telegraphs can be protected." An anonymous correspondent, who signs himself "W. A.," writes as follows:—"Instead of employing one cable ship and buoys, let the telegraph companies employ two cable ships, and when the cable is got on board and cut, anchor one of the steamer's leading chain on board from, say, the Lowestoft cable end, dropped down and resting on the bottom. The other ship will pick up cable to the spot where the break exists. Here a mark buoy would be let go, but the other or Emden end being close at hand and its position known with tolerable certainty, one drag of the grapnel would probably get hold of it. The buoy would consequently be required only for a short time. Then the ship would splice on the new cable and run, paying out new cable to bridge over the space back to her consort at anchor. The latter, seeing her sister ship approach, would get her end of the cable on board, and be ready for the end from the new bit; the two ends would be put on board of one of the ships, the splice be completed, and the repair thus effected, and so on with the other broken cable. This method is, of course, apparently expensive, but in the long run would be cheaper than keeping the ship knocking about uselessly for weeks in the North Sea. As I know from personal experience, the fishermen when they see a buoy in the line of their nets send off a boat, unshackle, and set the buoy adrift, or destroy and sink it, so as to avoid damage to the nets, thus leaving all the work of grappling and finding the cable to be gone over again. With a steamer at anchor, however, they would have to pull in their nets or cast them beyond the ship, or work on either side of her, and thus the work of repairing the cable would be completed." Mr. W. Andrews also writes:—"It would be much to be regretted if the attention drawn by *The Times* to the subject of interruptions to submarine cables, and the difficulties attendant upon their repair, were not utilised by information pointing out the precise causes of the mischief, so as to assist the initiation of workable remedial measures. These must, of course, in the main be of an international character. Local legislation has already constructed laws for the protection, regulation, and working of lines of telegraph on land, and Acts of Parliament in this country have further provided for the due protection of Imperial and public interests along the foreshores. The interests of the submarine cable companies, however, have apparently never come under consideration; at least, there is a remarkable absence of legislation concerning this class of property. What are the preventible causes of interruption in the case of submarine cables and what are the sources of difficulty in their repair? By making a list of both these the direction in which international agreement is needed will be apparent. First, submarine cables are very frequently broken by ships carelessly anchoring on the line of the cable, although this is laid down on the charts. Secondly, by ships carelessly dragging their anchors across the line of the cables. Thirdly, by twawlers, trawling with equal carelessness, and thus severing the cable. Fourthly, by the wilful action of the crews of both ships and trawlers, who, when they find their tackle caught by the cable, bring the latter to the surface, and instead of clearing it properly and letting it down undamaged to the bottom again, free themselves by cutting the cable asunder. Fifthly, by ships navigating perilously near the cable ships both in cable laying and cable repairing expeditions. Sixthly, by fishing boats casting their nets so as necessarily to drift across buoys and cable ships employed in repairing operations, thus impeding or rendering them impracticable; and, seventhly, the destruction carelessly or wilfully of buoys attached to cable ends or anchored as 'mark' buoys during repairs. All these careless or wilful acts might at least be reduced in frequency if made punishable under international law. International agreement and legislation consequent upon it appear to be demanded by the large public and private interests involved, and might apparently be secured without insurmountable difficulty. With respect to interruptions and damage arising from war preventive or remedial measures would not be secured

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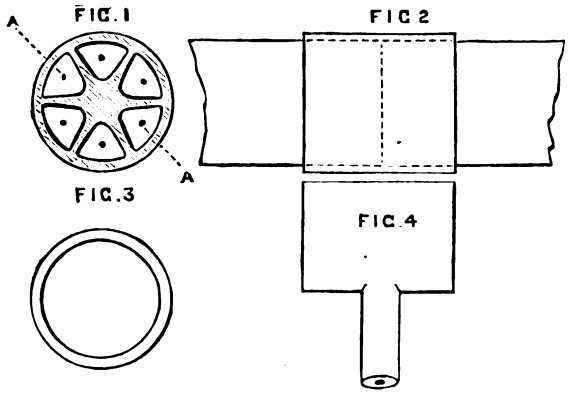
so simply, because these interruptions are influenced by an entirely different class of considerations. International lines, both terrestrial and submarine, have been destroyed during military operations, as well as local terrestrial lines, and in the case of the Indo-European line of aerial telegraph along the coast of the Black Sea, fifty miles were prostrated and destroyed, although in reply to representations made by the British Ambassador at Constantinople, under instructions from the Foreign Office, the Turkish Government had stated that 'instructions had been given for the preservation from injury' of this line. In like manner, the submarine cables of the West Coast of America Cable Company were intentionally severed during the recent war between Chili and Peru. Protective measures against careless or premeditated damage of an ordinary character should be sought in the first instance as not involving international questions of paramount importance, and therefore as affording reasonable prospects of speedy agreement. In such an agreement provisions to meet obstacles arising out of customs' arrangements as suggested by Sir James Anderson, and quarantine regulations which sometimes prevent communication between shore and ship at cable landings might perhaps be incorporated. The neutralisation of submarine cables might ultimately follow." Another letter also appeared from a "Telegraph Engineer," the tenor of which was similar to the letters given above. As this correspondence is still continuing, we shall refer to it again in our next issue.

NEW SYSTEM OF INSULATION FOR UNDERGROUND WIRES.

A new system of insulation for underground telegraph wires has been patented by Mr. W. B. Espeut, Spring Gardens, Jamaica. It consists in employing an iron tube lined inside with porcelain, such lining being formed in one or more longitudinal compartments, as desired, where heavy traffic is expected to be met with, or where there is not the risk of breakage from heavy traffic he uses tubes or pipes made of porcelain ware in lengths of suitable and convenient size, and connected by thimbles, to allow the end of one pipe to touch the end of the other pipe, care being taken to cement the two ends with white lead. These thimbles may be of iron or ware, as desired.



In the above illustrations, Fig. 1 shows an end view of one of these tubes, A A being the telegraph wires lodged in the several compartments of the tube. Fig. 2 is a side elevation of two such tubes butted end to end as they are to be laid out with a thimble, consisting of a short length of metal or porcelain ware or earthenware tube covering the ends. The thimbles should be an easy fit, and should be put on with white lead mixed to the consistency of paint, so that a perfectly water-tight closing may be insured. Fig. 3 is an end view of a thimble. Fig. 4 is a side elevation of a T-piece, which takes the place of a plain thimble at any point where a wire is to be led out or in. This system is designed to effect good insulation in as inexpensive a manner as possible.

CABLES AND LIGHTSHIPS, &c.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your last issue, November 19, 1881, of "Recent Inventions," I find No. "1087. Rotary Hawse Pipe for Keeping Telegraph Cables clear of Chain Cables connected to Lightships and other Vessels when Swinging with the Wind or Tide" (by Thomas Cockshott and A. M. Goodman), not proceeded with in consequence of an infringement upon my Patent Rotary Hawse Pipe (No. 2370, 11th June, 1880). Allow me to state that I have granted Messrs. Cockshott and Goodman a license to use my patent for the purpose above referred to, and I have no doubt of its practicability in conjunction with their improvements.—Yours, &c.,

J. A. BOXER, Commander R.N. (Retired).

No. 1, Marine-parade, Folkestone,
November 21, 1881.

THE LANE-FOX LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your remarks on the Lane-Fox lamp in your last edition of *The Electrician* I beg to submit a little practical information on the same. Having fitted up a quantity of Swan lamps, and finding after burning a few nights I had many breakages, I tried the Lane-Fox lamp, with, I am pleased to say, much better results, not having had *one* break for three weeks; and I think, as far as I can judge, they will run for six months. I have, therefore, no hesitation in saying that the Lane-Fox is the best lamp in the market at the present time.—Yours, &c.,

28, Culford-road, N., Nov. 19, 1881. H. A. KENT.

THE STORAGE OF ELECTRICITY.*

By SYLVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

Professor S. Thompson, of University College, Bristol, on Wednesday read an admirable paper on the subject of Secondary Batteries. This paper, together with that of Professor W. G. Adams, an abstract of which appeared in *The Electrician*, p. 26, vol. vii., has given us a fairly complete history, &c., of secondary batteries. Professor Thompson commenced his paper by referring to the statement of the late Professor Clerk Maxwell, that the greatest discovery of the last 15 years was the reversibility of the Gramme machine, the lecturer suggesting that the discovery next in importance was the reversibility of the voltaic battery.

The lecturer called attention to the two following principles:—

Firstly, that no kind of storage of energy, mechanical or electrical, is possible, except by doing work in overcoming some force which itself opposes the process.

Secondly, that the action in which work is thus done, must be one that is reversible; that is to say, to which there is an equal and opposite reaction.

ELECTRICAL ACTION AND REACTION.

"To every action there is an equal and contrary reaction." In these words Newton laid down the great fundamental principle of mechanical science. Its application is not limited to such mechanical reactions as the recoil of a gun, the return of a bent spring, or the mutual attractions of the planets, but reaches down into other departments of science. To Newton himself, we owe the simple experiment in which he proved the extension of the principle to magnetic forces. He found the magnet to be drawn towards a piece of iron with a force precisely equal to that with which it drew the iron to itself. It was left to Newton's great contemporary, Robert Boyle, to demonstrate that the same law held good also for the force of electric attractions; an electrified body drawing a non-electrified one towards itself, and being itself attracted with an equal and oppositely directed force. . . .

If you lift a pound of iron to a certain height against the pull of gravitation, the action implies the expenditure of a certain amount of energy, the equivalent of the work done. Precisely an equal amount of work (saving a trifling proportion converted into unuseful work of another kind, namely heat) can the mass of iron do in falling back again: for by its fall it may do the work of raising another pound to the same height. In the science of electricity and in magnetism the same fundamental principle holds good. . . .

An instance of electric action and reaction is afforded by the reversibility of dynamo-electric machines, such as that of Gramme. The Gramme machine can be used either as a generator or as a motor. If driven by the power of a steam-engine, or a gas-engine, or by wind-power, or water-power, or hand-power—in short, by any mechanical means whatever—it generates powerful currents of electricity, which may be used for producing electric lights, or any other kind of work that an electric current can do; the currents of electricity being due to the rapid movements of coils of wire fixed upon a rotating armature across a field of magnetic force, excited by the currents themselves in the machine. If, on the other hand, currents furnished by any suitable source are led by wires into the coils of a Gramme machine, these currents will drive it round, and will expend their energy in producing mechanical rotation, enabling the machine to be used as a motor. The reversibility of the Gramme machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric

* A Paper read before the Society of Arts, Wednesday, Nov. 23, 1881.

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currents. Set them to drive a Gramme machine, and let the Gramme machine, by means of a pulley, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the Gramme machine, and will generate currents as it runs down.

In the ordinary voltaic cells, currents of electricity are produced at the expense of a certain consumption of zinc and of acid. These materials may be regarded as the fuels of electric currents, just as coke and coal are the fuels of steam power. Like those fuels, they represent a store of energy. Zinc has a certain chemical affinity for oxygen. To separate an atom of zinc from one of oxygen, requires energy to be expended. When thus separated they have the chance of doing work in reuniting, this work generally appearing in the form of heat. When a piece of coal is burned, that is to say, is permitted to unite chemically with oxygen, its store of energy runs down, and manifests itself in the evolution of heat. A piece of coal represents a store of energy. So does a piece of zinc; for zinc can burn directly and give out heat; or may burn indirectly by being dissolved in sulphuric acid, also giving out heat. A Daniell's battery represents a store of energy.

An ounce of coal represents an amount of energy which, if entirely expended in doing work, would raise 695,000 pounds one foot high against the force of gravity, or would do 695,000 foot-pounds of work. In an ounce of gunpowder is stored about 10,000 foot-pounds of energy. An ounce of zinc represents a store of only 113,000 foot-pounds. An ounce of copper represents a store of about 69,000 foot-pounds only. An ounce of hydrogen gas will yield, by combiniug with oxygen, 2,925,000 foot-pounds of work. Joule first showed us how to make use of facts like these, in calculating by its mechanical value the electric power of voltaic cells. Let us apply these considerations to the storage of energy in any ordinary voltaic cell—say, for example, the Daniell's cell used in telegraphy. In this cell we have certain liquids containing zinc and copper, chemically dissolved in sulphuric acid, and into these liquids dip a plate of zinc and a plate of copper. The zinc plate slowly dissolves away, and at the same time, metallic copper is gradually separated out of the solution, there being about 1 1-20 ounce of zinc consumed for every ounce of copper deposited. Now, to separate an ounce of copper from its solution in sulphuric acid, requires 69,000 foot-pounds of energy to be spent upon it; and, as 1 1-20 ounce of zinc represents a storage of 118,650 foot-pounds, the consumption of this weight of zinc is enough to provide the 69,000 foot-pounds needed to separate the copper, and to leave a surplus of 49,650 foot-pounds. It is this surplus which goes to maintain electric currents in the circuit, and to electric work.

But, as we have remarked, the voltaic cell is reversible. If we take such a cell, and by means of some superior electromotive force drive electric currents back through the cell, the whole action will be reversed. Copper will be dissolved, and zinc will be deposited. The copper in dissolving will help the process by giving part of the necessary energy, and our currents will thus once more give us back pure zinc, and so separating out the zinc we do work and actually store energy.

Now, while we are thus using currents to separate the zinc from its solution, the zinc is all the while tending to re-unite. Its tendency so to re-unite—its chemical affinity, so-called—manifests itself as a counter-electromotive force; this counter-electromotive force being technically known to electricians under the name of "polarisation." Polarisation is the electric re-action at the poles or electrodes of a cell, and is of the nature of a counter-electromotive force. To send a current through a cell, we must apply an electromotive force at least as great as that to which the polarisation can attain, or we shall not overcome the tendency of the separate elements to re-unite. In fact, it is in overcoming this polarisation force, that we do the work of storage. We do electro-chemical work by overcoming electro-chemical forces, just as we do mechanical work by overcoming mechanical forces. In every case the storage is effeced by overcoming some reaction. If weights that have been lifted, and springs that have been bent, and metals that have been chemically separated, and did not tend to return to their former condition, none of these could serve as vehicles or instruments for the storage of energy. Without reaction, storage of energy would be impossible.

Laws of Polarisation.

To tear away an atom of any element from its compound with an atom of another element, requires the use of a definite amount of electricity, and necessitates further that this electricity should be urged forward with at least a certain minimum electromotive force. Take for example the case of the decomposition of water by the electric current. To tear away a single gramme of hydrogen from the oxygen with which it is combined requires no less than 95,050 webers to flow through. But these liberated and separated gases are in one sense a store of energy, and would, if allowed to combine together (by burning), produce heat. Their "affinity" for one another is very great, and the electric current has to do a considerable amount of work in tearing these two kinds of atoms away from one another. To see what this work amounts to, let us inquire how many units of heat they would evolve in burning. Careful measurements by Favre, Andrews, and Julius Thomsen, show that 34,000 calories of heat would result. Now the work done to separate the gases is of course equal to the work they would do by rushing together. The affinity of the gases manifests itself as a reaction against the electromotive force of the current employed to separate them. This reaction is itself a counter-electromotive force. When we overcome an opposing electromotive force by pushing a certain quantity of electricity from one point to another against its reaction, we do work just as truly as when we overcome an opposing mechanical force by pushing a certain lump of matter from one point to another against its resistance. In the particular case of the decomposition of water, the opposing electromotive force of polarisation has a magnitude when expressed in the proper units of 1·49 volts. It is possible, when we know how much heat would be evolved by the combination of an equivalent of any substance with oxygen, to calculate the amount of the electromotive force that would have to be applied to tear away that substance from its combination with oxygen.

The order in which the metals in the table are arranged is the order of oxidisability of the metals in the presence of dilute sulphuric acid. It also shows the order in which the metals stand in their power to replace one another (in a solution containing sulphuric acid). Thus if copper be put into a solution of platinum, the platinum is reduced, and some of the copper dissolves, evolving heat. If, however, zinc be placed in a liquid containing a copper compound, it displaces the copper, throwing down the latter as a metal and itself dissolving, while its surplus stored energy runs down as heat. In this order, too, the lowest on the list first, are the metals deposited by an electric current from solutions containing two or more of them; for that metal comes down first which requires the least expenditure of energy to separate it from the elements with which it was combined.*

In the preceding discussion oxygen has been taken as the standard electro-negative substance. But in point of fact there are substances more highly electro-negative. The highly electro-negative (or oxidising) property of the brown peroxide of lead was discovered in 1835 by Munck, of Rosenschöld, who describes it as being the most highly electro-negative substance known, being superior even to the peroxide of manganese which Volta found so highly electro-negative. The peroxide of silver is still more highly electro-negative. This power can easily be verified by making a small voltaic cell with a pair of plates, the one platinum, covered with a film of peroxide of lead, the other of zinc. One such cell will decompose water, which a copper zinc pair will fail to do. For to do this requires, as may be seen by the table, an electromotive force exceeding 1·493 volts, this being the measure of the affinity of hydrogen for oxygen. The platinum zinc pair would have an electromotive force of only 1·044 volts, while that of a peroxide of lead zinc pair is about 2½ volts.

The electromotive force of polarisation in a cell, evoked there by the passage of a primary current through it will depend upon what circumstances are produced at the two electrodes by the passage of the current. For each electrolyte there is a minimum electromotive force, without which complete decomposition cannot occur. For water this minimum is 1·495 volts. If the current be of less electromotive force than this minimum, the action may begin, but the charging current will be stopped the moment the opposing electromotive force of polarisation has risen to an equal amount. It is for this reason that in charging a Planté cell or a Faure cell, we must use at least two cells of Grove's or of Bunsen's battery, or at least three cells of Daniell's battery.

The chemical work that is done in any secondary battery, or electrolytic cell, is proportional to the strength of the charging currents, to the time it lasts, and to the effective minimum electromotive force of polarisation in the cell itself. It is not increased by increasing the electromotive force of the charging current much beyond this value: for though a higher counter electromotive force may be temporarily called out, the work done against this added opposition is wasted in local heat, which is detrimental to the power of the cell. The cells should be charged with only just sufficient electromotive force to overcome their reaction. To charge a Planté cell two Bunsen cells—not twenty—should be used. The storage will be slower, it is true, but it will be more economical by far.

Storage Power Lessened by Heat.

Heat diminishes the counter electromotive force of the cells during charging; it therefore diminishes the amount of chemical work done in charging them, and diminishes the amount of charge thereby stored. Secondary batteries should be kept as cool as possible during charging. A simple experiment in proof of the diminution of polarisation by rise of temperature is the following. Let a single Grove's cell be connected with a water-volameter; no gases are evolved until the voltameter is heated to near boiling, when the gases come off freely. Bartoli examined the electromotive force of polarisation in a cell containing sulphuric acid with electrodes of platinum, and found it to be twice as great when the liquid was at 5° C. as when raised to its boiling point. Beetz and Robinson have independently investigated the same effect, and their results agree precisely. Beetz found the polarisation 2·216 volts at the ordinary temperature of 20° C., and as the temperature was raised it fell off, gently at first, more rapidly afterwards, till at 100° C. it was only 1·904 volts.

Temperature deg. C.	E.M.F. (Beetz).	E.M.F. (Robinson).
16	2·216	...
20	..	2·216
30	...	2·194
43	...	2·148
53	...	2·105
57·5	2·101	...
60	...	2·095
80	...	2·040
94	1·960	...
100	...	1·904

(TO BE CONTINUED.)

* The calculation of the figures in the second column (the electromotive forces) from those of the first column (the number of the calories of heat evolved by the oxidation and solution of that amount of the substance that is chemically equivalent to one gramme of hydrogen) is effected in a manner originally suggested by Mr. Joule and Sir William Thomson. The number of heat units or calories is ascertained by direct experiment in the calorimeter in the manner familiar in the researches made on heat of combination by Favre, Andrews, Julius Thomsen, and Berthelot. Now, Faraday showed that the qualities of metals concerned in the electro-chemical operations in voltaic and electrolytic cells are proportional to their chemical equivalents; and the later researches of Weber, Kohlrausch, Mascart, and Alder Wright have shown that this proportionality can be expressed by a numerical co-efficient, which we may call the "Faraday co-efficient," and which will depend on the unit in which electrical qualities are expressed. If we take the "weber" as the unit of electric quantity, then the Faraday co-efficient is 0·000,105, or in other words, each weber of electricity which passes through a cell will involve the liberation or combination of 0·000,105 grammes of that element, whose chemical equivalent is 1, and proportionally more of those whose chemical equivalents are greater. The heat value of the chemical work done by one weber of electricity, in removing or depositing any metal in any cell, is obtained by multiplying by 0·000,105 the figure standing opposite the metal in question, in the first column of the table. These heat values are turned into absolute units of work by multiplying by Joule's mechanical equivalent of heat, which is, in the centimetre-gramme-second system of units, equal to 41,530,000, or 41·53 × 10^6. But the work done in moving a unit of electricity against the reaction in a cell measures the power of that cell to react electrically, or, in other words, measures its electromotive force relatively to oxygen, which is taken here as the standard electro-negative substance. These electromotive forces will be expressed in terms of the appropriate of electromotive force, the volt.

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AMENDMENT OF THE PATENT LAWS.

The Society of Arts cannot be congratulated upon the reception accorded to its proposed Bill for amending the Patent Laws. The draft of the measure prepared by the society's committee has been before the public now for several weeks, and during that time we do not remember to have seen it cordially noticed anywhere, whilst criticism of an adverse kind has been plentiful and severe. Probably the discussion which is to take place at the society's rooms next week may result in removing some of the most conspicuous blemishes of the Bill, and in that case there may be a chance of its reaching the House of Commons. Of its becoming law there is less probability. In the present temper of Parliament a full discussion of the whole bearing of the Patent Laws which such drastic alterations as those recommended by the Society of Arts would involve has very little chance indeed; and without full discussion no material alteration is possible. The consideration of this question, however, which has been provoked by the appearance of the draft Bill, backed as it is by the authority of a body so well informed as the Society of Arts, is of considerable value, and may possibly clear the way for legislation at some future time. Without in the least presuming to forestall next week's discussion we may venture to offer a few remarks upon some of the main features of the scheme itself.

At the outset we may take leave to affirm that the Bill has been constructed exclusively in the interests of inventors. That the public has any rights in the matter never seems to have entered the minds of the framers of this new system of monopoly. This alone, we think, would be fatal to its prospects as a serious proposition for the Legislature. The correspondence we have recently commented upon complaining of the costliness of applied inventions, intrinsically of small money value, but rendered almost prohibitive by the patent rights of the vendors, shows unmistakably the views entertained by the non-inventing community. What is cheap is rendered dear, what is naturally abundant is rendered scarce, by the action of the Patent Laws, or rather the action taken under the protection of those laws. This, at least, is what the purchasers think; and while they are in this frame of mind it is hopeless to expect them to approve a measure that enlarges rather than diminishes the area available for professional patentees. One remarkable clause of the Bill reads as follows:—"An invention is deemed new for the purposes of this Act if it has not been published or publicly used in the United Kingdom . . . . within thirty years immediately preceding the date of the application of a patent for it." Thus, any one taking the trouble to resuscitate a disused invention, or a discovery for which no practical use has been found, during a period of thirty years, can patent it as his own property. All that need be said of a proposition such as this is that if it is good for one person it is good for another, for if A has a right to appropriate public property by reason of disuse, B has an equal right, and so, for that matter, has the whole alphabet. But it is certain that no Legislature entrusted with the interests of the public would assent to their invasion in this manner.

But not only does this Bill enlarge the area of patents, it adds considerably to their possible number. Under the four definitions describing what a patent may in future consist of there is hardly any process, method, product, or result, that may not conceivably be covered by a protecting monopoly. The scope of these definitions might be narrowed when legal hands come to put them into shape; but it is impossible to avoid the conviction that the lay framers of the clause meant it to be as wide and elastic as possible. There may be good reason for this; we do not pretend to argue the point; but it must be obvious to anybody not blinded to every interest save that of the patentee that the public will emphatically protest against such flagrant encroachment on its rights.

The formation of a Board of Commissioners of Patents, which is one of the principal innovations under this Bill, is explainable only on the assumption that no lawyer has been consulted in the framing of it. All actions for infringment of a patent are to be no longer tried before Her Majesty's Courts of Justice, but before three commissioners, one of whom shall be an experienced engineer, one experienced in chemistry, and the third experienced in the law. The practical question raised by this suggestion is, would the decisions of such a court give satisfaction? Would it in the least discourage litigation or lessen its expense? Would the opinion of an expert acting as judge have more weight than his sworn testimony acting as witness? We apprehend not; and although there is about this proposition an air of prompt despatch and businesslike avoidance of the law, we strongly suspect that the majority of disputants would greatly prefer the law. This, however, is a matter that concerns patentees themselves, and they will, no doubt, say what they think about it. We shall be curious to learn what, also,

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they think of the provisions against infringements of patents. Their bearing is difficult to comprehend, because they are framed apparently in the interest of two different and often antagonistic classes. There are inventors and there are improvers—some people call them pirates—but both are given to patenting, and both, therefore, share the solicitude of the Society of Arts. The way in which it has endeavoured to protect a primary patent on the one hand and encourage the secondary patentee on the other is most edifying. A discussion between these two parties, if only they could be induced to speak their minds freely and in public, would be still more instructive. This, we fear, however, is hardly to be looked for at the forthcoming meeting.

The one party, as we said before, whose interests are not considered at all is the public. Now, what the public wants is, first, to encourage invention, and, secondly, not to pay too dearly for it. Under the present Patent Laws there is a widespread suspicion that neither of these ends are secured. The reform that is called for would seem to be some alteration affecting the proprietorship of an invention and all that pertains to it, rather than a remodelling of the procedure under existing conceptions of proprietary rights. The whole subject is as complicated, and almost as demoralising, as the laws relating to bankruptcy, and its reform is probably even more remote; but the tendency of current opinion for many years past has been adverse to the sale of monopolies, though favourable to the claims of invention. To reconcile these two apparently conflicting propositions would be a task worthy, indeed, of our best endeavour. We greatly regret that the Society of Arts has not even attempted it.

CRYSTAL PALACE INTERNATIONAL ELECTRIC EXHIBITION.

We are informed that allotments of space have already been made to the following exhibitors, and that other allotments are being made as quickly as possible:—

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THE PARIS EXHIBITION.

The show in the Palais de l'Industrie is closed. The tendency of the sightseer is no longer towards the Champs Elysées, in order to see Aladdin's Palace. Other attractions may take the place of the Electrical Exhibition. Other electrical exhibitions in the near and distant future may be as large and as good, but we doubt if ever the same amount of interest will be shown in an electrical exhibition as has been shown in this at Paris. Thirty years ago the first great International Exhibition was opened in London; since then many exhibitions have been held in various parts of the world, showing the idea first mooted by the Society of Arts in 1845 to have been of great value, and the results to be appreciated wherever civilisation reigns. We have, however, a very tangible memento of this first great exhibition in the aërial building of Sir J. Paxton, which was removed to Sydenham, and is now known to us as the Crystal Palace. It having been decided to hold an electrical exhibition in England, what building, then, better suited for this purpose than the one around which clings the memories of the first great success? The exhibition to be held at the Crystal Palace may be, or may not be, more valuable scientifically than the one just closed. Time alone will show; but one thing is certain, that numbers unable to visit Paris will be enabled to see the wonderful progress made in this special application of science during the past few years. Before we resume our report of the exhibits at Paris, it may be interesting to notice that only one name appears in common in the Report of the 1851 Exhibition and the list of exhibitors at Paris, under the heading "Application of Electro-Magnetism to the Movement of Machines," viz., that of "Froment." In the French section, under a glass case, a series of machines by "Froment" were shown, by means of which the gradual development of his ideas, and knowledge of the capabilities of such machines, are easily seen. The other exhibitors at the 1851 Exhibition mentioned under this heading were—Joule, Harrison, Knight and Sons, Watkins and Hill, Allen, Cresswell, Breton and Hjorth. With the exception of Mr. Harrison, whose work is too little known, we do not remember that any one of these gentlemen continued their investigations for the improvement of such machines; indeed, we ought not even to except Harrison, whose more recent work has been more closely connected with lamps than with machines. The jurors of the 1851 Exhibition said:—"This application (of Oersted's discovery), which has since engaged the attention of scientific men, is pretty well represented in the Exhibition. Although no great power has as yet been obtained, many important difficulties in its practical application seem to have been overcome, particularly by Mr. Hjorth, and we cannot help flattering ourselves that the attainment of this mysterious motive force will soon be followed by the making it available for practical purposes." The machines shown in 1851 were, however, altogether of a different class to those shown at Paris in 1881. The prescience of the 1851 jurors was correct, and electricity is available for practical purposes.

In 1852 Holmes improved upon the Alliance Machine.

In 1857 Siemens introduced his armature.

In 1864 Pacinotti published a description of his machine, with continuous ring armature.

In 1866 Wilde made his first form of machine.

In 1866 Siemens and Halske introduced the self-exciting principle.

In 1867 Ladd utilised the same principle.

In 1867 Wheatstone also developed the same principle.

In 1871 Gramme first described his continuous current machine.

In 1873 Wilde introduced his second form.

In 1874 Lontin machine for several circuits brought out.

In 1875 Siemens machine described.

In 1878 Gramme's alternating current machine introduced.

Since 1878 the machines generally in use have been introduced, except that of Siemens, which, as will be seen, was described in 1875. Among these machines we may name the Brush, the Bürgin, and that of Edison, whilst there are several other claimants for public favour, such as the machine of Andrews, of Ball, of Heinrichs, of Maxim, of Schuckert, &c., some of which, however, were not in the Paris Exhibition. Among the historic apparatus, the Pacinotti machine was, undoubtedly, the most interesting, inasmuch as it is the first machine clearly described with the type of armature now so extensively used. Dr. Antonio Pacinotti's machine was devised in 1860, and constructed by him for the Physical and Technological Cabinet of the University of Pisa. A description of it was, in June 1864, given in the Italian scientific periodical, *Il Nuovo Cimento*. The entire paper is a little too long to give a complete translation, we content ourselves, therefore, with merely abstacting the portions relating to general matters, and give fully those portions relating to the details of the machine. Dr. Pacinotti commences by referring to his having constructed the machine, and calls it a little model electro-magnetic machine, with an electro-magnet of a special kind. This electro-magnet, independent of its novelty, he deems peculiarly suited to give regularity and constancy of action. The form of this electro-magnet is a circular ring. The inventor then

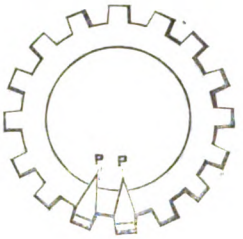

Fig. 1*a*. Fig. 1*b*.

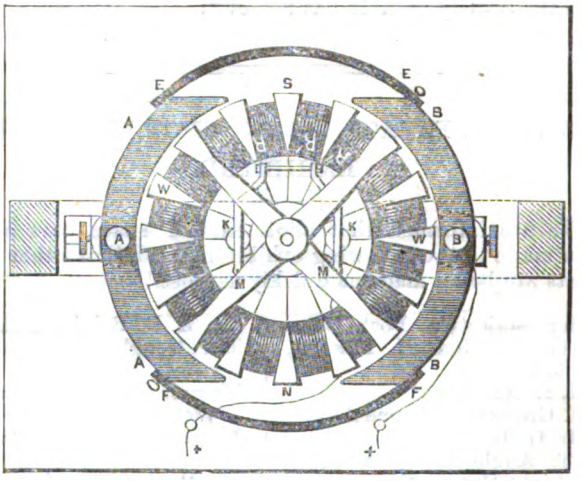

Fig. 2.

describes his theory of the action of the ring, and explains that the ring used in the construction of his little machine is thus made:—An iron ring having the shape Fig. 1*a* was made, furnished with sixteen teeth as represented. This ring is fastened to four brass arms, M M, shown in Fig. 2, connected with the rotating axis of the machine. Between the teeth are placed triangular prisms or wedges of wood, P P (Fig. 1*a*), and the space between each pair of wedges filled up regularly with insulated copper wire. These coils are shown at R R′ R″, the wire being wound continuously in the same direction, each coil being formed of nine turns. Two consecutive coils, such as R R′, are separated by a tooth of the ring and the wedge of wood.

The axis to M M (Fig. 3) carries the wheels so constructed. The wires at the end of each coil and the wires at the beginning of each coil pass through slots made for this purpose in a wooden collar, centered on the axis, and from there to the commutator, also on the axis.

This commutator consists of a small boxwood cylinder, having circumferential slots, into which are inserted 16 brass pieces, eight in the upper slot and eight in the lower, concentric to the wooden cylinder, from which they project slightly,

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and the thickness of which separates one row from the other. Each of these brass pieces is soldered to two ends of the wire, which, as previously mentioned, come, the one from the end, the other from the beginning of two consecutive coils.

The iron ring with the bobbins wound upon it in the manner already described was mounted in a horizontal position between the two legs of a powerful electro-magnet, the distance of which from the ring could be adjusted at pleasure by means of a set screw and a slot in the lower connecting cross piece. Contact rollers K K were made to press one on each side of the axis against the lower wooden disc carrying the strips of brass, so that during the rotation of the ring all of the latter were brought successively into contact with them. When, therefore, the terminal posts H H^1 are placed in connection with the poles of a battery the current will pass, supposing it to enter at H (+) by way of the binding posts L to the roller K and through the strip of brass on the disc, against which the roller may happen to press at the time, up the two wire coils of the armature, whose point of junction is in connection with this strip of brass. The current here divides, each portion passing in an opposite direction through the coils surrounding each half circumference of the ring, to meet again to form one current at the left contact roller K, whence the united current passes to L^1. From here the current passes through the coils of the electro-magnet, passing then

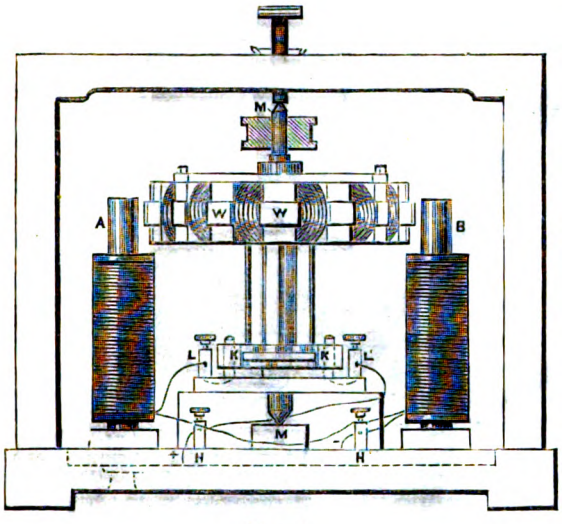

Fig. 4

by H^1 to the negative pole of the battery. Magnetic poles thus become developed in the ring at points N S (Fig. 2). In order to obtain the best effect from the electro-magnet, Pacinotti provided the two poles with soft iron extensions A A A, B B B, which were made to surround the ring very closely for over two-thirds of its circumference. Strips of brass E E, F F were attached to these pole pieces to give them greater rigidity. In the elevation of the machine here shown the pole pieces are left out in order to show the ring more clearly. Pacinotti indicated, in the article before mentioned, the way by which this machine might be made into a magneto-electric machine, to produce continuous currents with a constant direction.

On substituting for the electro-magnet A B a permanent magnet, and on rotating the ring armature, the poles induced in the ring by the proximity of the magnet will always be found at the extremities of the diameter passing, when produced, through the poles of this exterior magnet, so that the coils alone may be taken as rotating, while the poles produced by induction remain at rest. The current induced in any particular coil will, in the motion of the latter from N to S, preserve the direction it has on leaving N until it reaches a point midway between N and S. Here a reversal in the direction of the current takes place, which new direction is preserved till the coil arrives at a point midway between S and N, when a reversal to the former direction occurs. The currents are then best collected by brushes upon the commutator at right angles to the magnetic axis of the rotating armature.

Several experiments with this machine are described, the rotation of the armature being obtained by means of a cord upon the large wheel, as shown in Fig. 4, round an axial wheel. Some of these experiments were made to show the work expended upon and obtained from the machine, others to find the equivalent battery power required to do the work, in order to obtain which Dr. Pacinotti introduced in the circuit a sulphate of copper voltameter, the copper plates of which were weighed both before and after the experiment. Of this experiment he says:—"I give herewith the figures which I obtained in one of these experiments made with the small machine with transverse electro-magnet. This machine, the wheel of which was thirteen centimetres in diameter, was actuated by a battery of four small Bunsen cells. It elevated to a height of 8·66 metres, a weight of 3·2812 kilogrammes, taking account of the friction, the result being that it did mechanical work of the following value, viz., $8{\cdot}66 \times 3{\cdot}2812 = 28{\cdot}415$ kilogrammes. The positive copper plate of the voltameter diminished by ·224gr., the negative increased by ·235gr., so that the mean of the work done in the voltameter was represented by ·229gr. This number, multiplied by the relation between the equivalents of the zinc and copper, and by the number of battery cells, gives the weight of zinc consumed as ·951gr. Thus, to effect

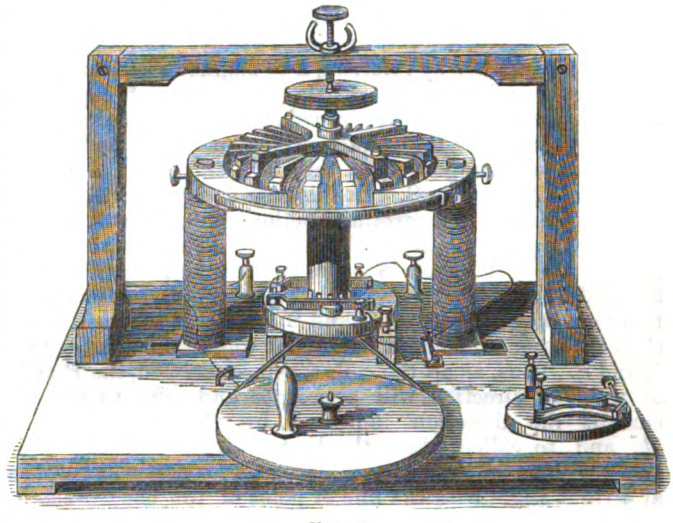

Fig. 5.

one kilogrammetre of mechanical work there was consumed in the battery 33 milligrammes of zinc. In another experiment made with five cells 36 milligrammes per kilogrammetre were consumed.

"These results, I am aware, do not place the new model notably above other small electro-magnetic machines; nevertheless, they do not seem to me to be very bad, if we consider that they were obtained with a very imperfect machine, in which there were faults of construction which are not met with in other machines of this kind. I should point out, amongst other things, that the commutator is of brass and badly mounted on its axis, so that all the contacts are not always effected as they should be.

"The reasons which determined me to construct the small electro-magnetic machine which I have just described were as follow:—

"1. In the arrangement adopted the current never ceases to flow in the helices, and the machine is not set in motion by a series of more or less rapidly succeeding impulses, but by a couple of forces which are in continual action.

"2. The circular form of the rotary magnet helps, with the foregoing method of successive action, to give a regularity of motion, and to avoid the loss of useful power by friction, &c.

"3. In this machine I have not tried to effect the instantaneous magnetisation and demagnetisation of the iron of the electro-magnets, which is prevented by the extra currents and the coercitive force of which we can never quite deprive

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the iron; but simply that each part of the iron of the transverse electro-magnet, continually under the influence of suitable electro-dynamic forces, should successively pass through different degrees of magnetisation.

"4. The armatures of the fixed electro-magnet pursuing their action on the teeth of the magnetic wheel, and influencing a sufficient number of these teeth, never cease their motion as long as there is any magnetism left in the teeth.

"5. The sparks increase in number, but diminish in intensity, whilst there are no strong extra currents when the circuit is opened, which may remain always closed. Only when the machine is at work is there an induced continuous direct current of opposite character to the battery current. The value of this kind of machine seems to me to be the facility with which it can be transformed from an electro-magnetic into a magneto-electric continuous current machine. If, instead of the electro-magnet A B (Figs. 3 and 4) there were a permanent magnet, and the transverse electro-magnet were made to revolve, we should have a magneto-electric machine which would give an induced continuous current always flowing in the same direction.

"To ascertain the best position for the resistances on the commutator in order the better to collect the induced current, it may be remarked that by the influence exerted on the movable electro-magnet opposite poles are formed at the end of a diameter line opposite to the poles of the fixed magnet. These poles, N S, maintain a fixed position, even when the transverse electro-magnet revolves on its axis. We may, then, whether by referring it to magnetism or to induced currents, consider or suppose that the coils of copper wire revolve in a string on the circular magnet, this remaining fixed. To consider the induction currents developed in these coils, let us suppose that they are traversing a position from pole N to pole S. In this case a current will be developed in the coil in a certain direction, so that it will arrive at the middle point *a*. From this point the current will take an inverse direction. From S let us go through N until we reach the middle point *b*; the currents will maintain the same direction that they did between *a* and S; leaving *b* they will change their direction and again take that which they had between N and *a*. Thus, as all the coils are in connection, the E.M.F.'s of a given direction will aggregate and give to the total current the direction indicated by the arrows in Fig. 1*b*, and to collect them the best positions for the resistances will be *a b* on the commutator, which will be placed at a right angle with the line of poles of the electro-magnet. The induced current changes direction with the change in the manner of rotation. And, as to the commutator, when the resistances are on the diameter corresponding to the line of the poles, whatever way the electro-magnet may turn, they will collect no current. Leaving this position, if we turn them to one side we have a current of an opposite character to that obtained by removing them the opposite way.

"To develop an induced current with a machine of this construction I have brought the opposite poles of the two permanent magnets near to the magnetic wheel, or I have magnetised by means of a current the fixed electro-magnet, and I have caused the transverse electro-magnet to revolve on its axis. In both the first and second cases I obtained an induced current of the same character, which caused the galvanometer to indicate a certain intensity, even after having traversed sulphate of copper or water acidulated with sulphuric acid.

"This second method is impracticable, of course, but it is easy to replace the temporary magnet A F F B by a permanent one. The magneto-electric machine which we should thus have would give us a greater sum of induced currents all of the same character, without its being necessary to employ mechanism to separate opposite currents, or to cause them to aggregate.

"This model further shows the reciprocity existing between the electro-magnetic and magneto-electric machines, since in the first the current, which has been introduced by the resistance *l l'*, by traversing the coils, accomplishes the motion of the wheel and its mechanical work, whilst in the second mechanical work is employed to set in motion the wheel, and to obtain, by the effects produced by the permanent magnet, a current which traverses the coils."

Passing from the Italian Section to that of America, we see in the Edison machine one of the latest developments of the germ introduced by Pacinotti. Edison has aimed at simplicity and economy, and a brief description of his machine will enable our readers to form some opinion as to how far he has succeeded. It is impossible to give absolute figures, but the agents of Mr. Edison both at Paris and in England have continually promised that facilities should be given to obtain measurements. Unfortunately, at Paris Mr. Edison's large machine was late in arriving, and later still in being put to work, so that these measurements have been deferred till an opportunity arises for investigation either at the Crystal Palace or some other place in England. We have already referred to the Edison lamps. We have called attention to the completeness of his system, but it remains for experience to test the economy of the system.

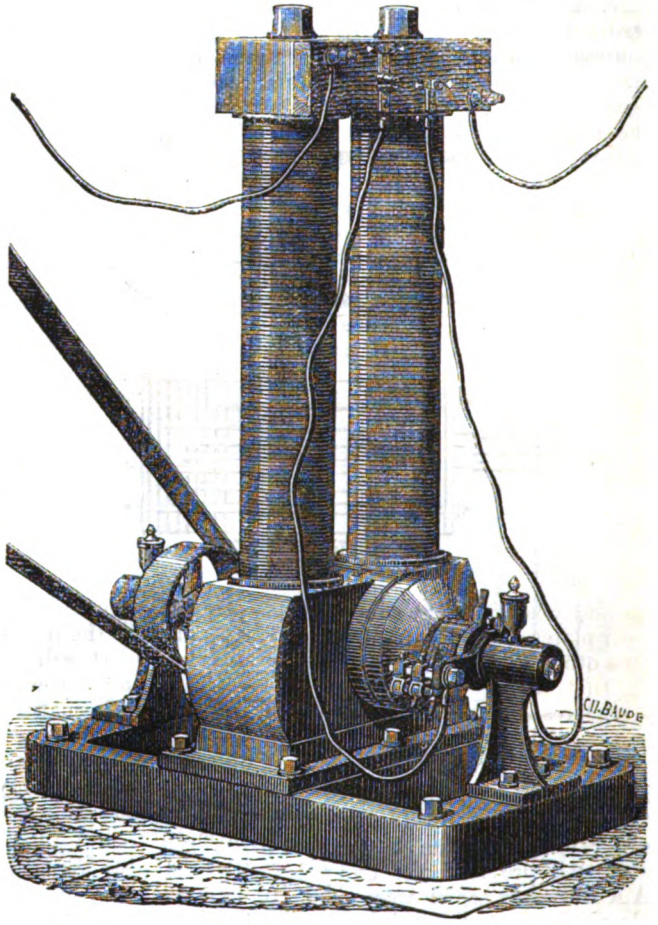

FIG. 5.

A general idea of Edison's machine will be obtained from Fig. 5, which illustrates one of his small machines. The principle, however, both of his small and his large machines is the same. We are glad to see that the opinion expressed by Professor Perry in his lecture to the Society of Arts regarding large machines is taking root, and that constructors are beginning to understand that large machines tend to greater economy. Mr. Edison's machine is not designed to suit the taste of æsthetic individuals, but every part is supposed to be designed for economy. We think the poles of the machine partake a little too much of the form of lamp posts, and we certainly should like to know the reasons why this particular form and size have been adopted. Professor Rowland has, we understand, mathematically investigated the proportions best suited for dynamo machines, and there is little doubt as to the accuracy of the investigations by such an accomplished and careful mathematician. The first peculiarities of the Edison machine that strike the observer are the long arms and the extraordinarily heavy pole pieces of the electro-magnet, but we think the greatest ingenuity has

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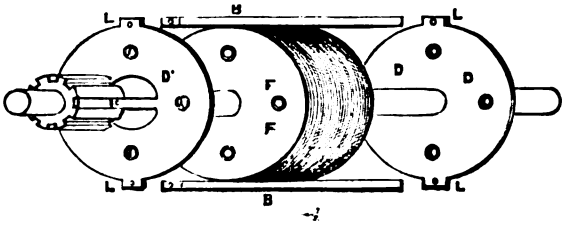
been shown in the construction of the armature. It is difficult to conceive of anything more simple, or that can be more cheaply constructed. As we have before mentioned, its economy we have not determined. The armature consists of several parts. The central part, forming the core of the armature, shown by F F, Fig. 6, is made of thin, soft, iron discs, insulated from each and from the shaft. The discs are perforated, as shown, in order to allow of bolts being passed through, by which means the whole series of plates are securely held together. The bolts, of course, are insulated from the plates or discs. At the end of the core, away from the armature, are a number of copper plates, D D, perforated as shown to slip on the axle, and to be fastened and fitted with the lugs L L, to which copper bars can be attached. Somewhat similar copper discs are used at the armature end, but the central perforation of the disc is much larger, as will be seen in D^1, and a portion is left to form a tongue, C. This tongue is used to form the contact pieces in the commutator. The commutator H is formed of insulating material grooved on its surface with grooves equal in width and depth to the tongues left on the copper plates. The tongue, bent outwards, slides into the groove of the com-

FIG. 6.



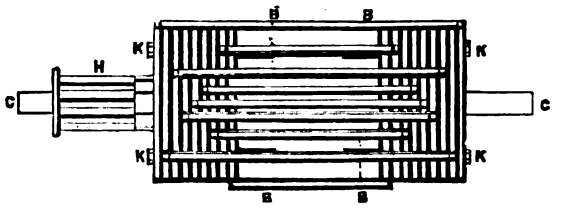


FIG. 7.

mutator, each tongue having its proper groove. The copper plates at the commutator end are joined to the plates at the other end by copper bars, B B (Fig. 7). It will be seen that these copper bars, with the connecting plates or discs, correspond to the wire coils of the ordinary armature. The bars B B are insulated from the core F F, by leaving a little air space between. Of course, unless the armature is carefully protected from dust and metallic particles, or any other conducting material, contact might often be made between the bars and the core. The armature, however, is carefully protected. It will thus be seen that this armature is built up of the simplest forms—the discs, insulating pieces, bars, &c., can all be stamped or cut by machinery, involving little expense compared with that of winding. If any mishap occurs to any part of the machine the repairs are soon done, and the time lost is very short. The armature is connected to a wooden tube carried by the axle. The resistance of such an armature is exceedingly small, and Mr. Edison claims to have arrived practically at a similar solution of the problem of the relation of internal resistance of dynamo machines to external resistance as that Sir W. Thomson demonstrated mathematically at the last meeting of the British Association.

AUSTRALASIAN TELEGRAPH STATISTICS.—According to the statistics relating to the whole of the Australian colonies for the year 1880 there were on the 31st of December of that year the following number of miles of telegraph wire open, viz.:—New South Wales 13,188, Victoria 6,019, South Australia 6,904, Queensland 8,150, Tasmania 1,096, Western Australia 1,592, New Zealand 9,401—total 46,350; whilst the number of miles in course of construction was stated to be:—New South Wales 501¼, Victoria 132, South Australia 515, Queensland 567—total 1,715¼.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES NOV. 23.		BUSINESS DONE WEEK ENDING NOV. 23. Highest.	Lowest.
Anglo-American	53⅜,	54½	54¾	53⅜
Do. Preferred	82,	83	84½	82½
Do. Deferred	23⅜,	24	24¾	23¾
Brazil Submarine	11,	11¼	11¼	11
Cuba	9½,	10	—	—
Do. Preference	16,	17	17	17
Direct Spanish	5¼,	5½	—	—
Do. Preference	14½,	15½	—	—
Direct United States Cable	10⅞,	11¼	11¼	11¼
Eastern Telegraph	10¼,	10⅜	10⅜	10⅜
Do. 6 per Cent. Preference	12⅜,	13	12⅜	12⅜
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	10⅞,	11¼	11¼	10⅞
German Union	10⅛,	10⅜	10⅜	10⅛
Globe Telegraph and Trust Company.	6½,	6¾	6¾	6¾
Do. Preference	12½,	12¾	12¾	12¾
Great Northern	12½,	12¾	12⅝	12⅝
Indo-European	27½,	28½	—	—
Mediterranean Extension	2½,	3	—	—
Do. Preference	9½,	10	—	—
Reuter's	12,	12½	—	—
Submarine	290,	300	—	—
West India and Panama	1⅞,	2	1¾	1⅞
Do. 1st Preference	7⅞,	8	7⅞	7 11-16
Western Brazilian	7⅛,	7⅜	7⅛	7 5-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	⅛,	1⅛	1 1-16	15-16
Oriental	⅛,	⅛	⅛	⅛

ELECTRIC LIGHT.

Electric Light and Power	1⅛,	⅜	1⅜	1⅜
Anglo-American Brush	7⅞,	8¼	8¼	7¾

TRAFFIC RECEIPTS FOR OCTOBER, 1881.

COMPANIES.	Oct., 1881.	Oct., 1880.	Increase.	Decrease.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	2,063	1,821	242	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,164	29,061	2,103	—
Eastern Telegraph Company	48,872	45,570	3,302	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

BROOKS' UNDERGROUND TELEGRAPH COMPANY.—At a meeting of the Brooks Underground Telegraph Company, of New York, held in the office of the Western Union Telegraph Company on the 9th inst., General Stager, the president, made a very encouraging report of the lines laid during the past two years. A cable of thirty conductors had been laid between Jersey City and Newark, a distance of ten miles, which gave excellent results, sufficient to warrant the work being continued to Philadelphia. The other specimens for river crossing and through tunnels had given satisfaction. The work now in contemplation in New York, Philadelphia, and other eastern cities would require more of his attention and time as president than he could spare. He would, however, take the vice-presidency if the Company so desired, and give a portion of his time to the affairs of the Company in Chicago and other western cities. Thereupon Dr. Green nominated Mr. David Brooks, of Philadelphia, for president, and General Stager for vice-president, who were elected. Mr. Clarence Carey was elected secretary and treasurer.

ELECTRIC LIGHT AT THE ALHAMBRA THEATRE.—After being closed for several weeks for redecoration, the Alhambra Theatre will re-open on Saturday, December 3rd, with an English version of *La Biche au Bois*, under the title of the "Black Crook." We understand that the dome is to be illuminated by the electric light, which will no doubt add to the general effect.

On Nov. 21st, at 25, Rue Armeny, Marseilles, the wife of George F. Lawson, Esq., of twins—boys.

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RECENT INVENTIONS.

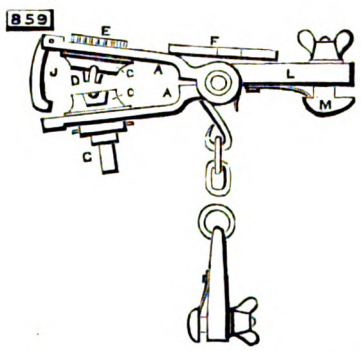
ABSTRACTS OF SPECIFICATIONS.

844. GALVANIC BATTERIES, *F. Wirth.*—28*th February*, 1881.—(*A communication from E. M. Reiniger.*)—(*Not proceeded with.*) 2*d.*

The invention consists in making the cells of batteries angular in section, with a recess of such size that the external fittings are included in the recess and thus protected, and also in combining the cells to form a battery by placing them in one row where contiguous elements are separated by a partition, each partition having an aperature.

859. ERECTING AND REPAIRING OVERHEAD TELEGRAPH WIRES, *J. W. Fletcher.* 1*st March*, 1881. 6*d.*

This relates to what are known as draw vices in which there is a gripping piece or vice, and a winding pulley or roller. The frame carrying the winding pulley consists of two arms, A, jointed together, the pulley C being in two halves, pivotted one in each arm, and one carrying a projecting square, D, fitting a recess in the other half. To one half a ratchet wheel, E, is secured,



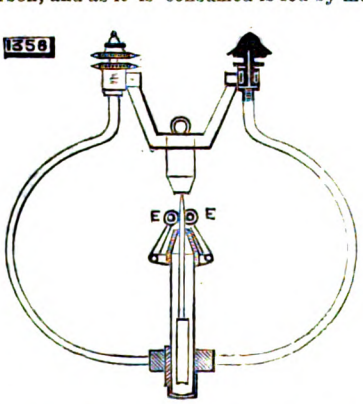
and with it the pawl F engages. The spindle G of the other half is square to receive a handle by which the pulley is revolved. Recesses are formed in the two halves to receive the end of the wire. One arm of the frame is prolonged, and forms one jaw of a vice; the other jaw, M, having a stem passing through a hole in L, its outer end being screw-threaded, and fitted with a thumb nut. The latch or bolt J serves to keep the arms A in the locked position.

1240. ARMATURES FOR DYNAMO-ELECTRIC MACHINES, &c., *E. G. Brewer.*—21*st March*, 1881.—(*A communication from T. A. Edison.*) 6*d.*

The cores of these armatures are built up by insulated iron discs on a wood axis. The wire coils of the ordinary armature are replaced by copper bars connected by copper discs insulated from each other and from the core.

1358. IMPROVEMENTS IN ELECTRIC LAMPS, *R. Harrison and C. Blagburn.*—26*th March*, 1881. 6*d.*

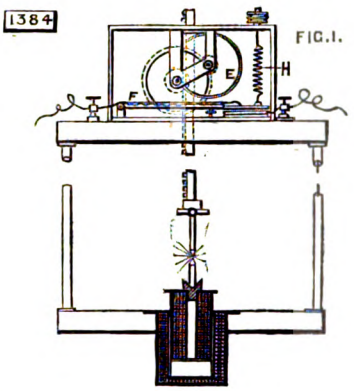
The lower carbon impinges upon a large block of carbon, and as it is consumed is fed by means



of the rollers E E, which have a grip on the carbon and are actuated by weights.

1384. ELECTRIC LIGHTING APPARATUS, *W. R. Lake.*—29*th March*, 1881.—(*A communication from A. G. Holcombe.*) 6*d.*

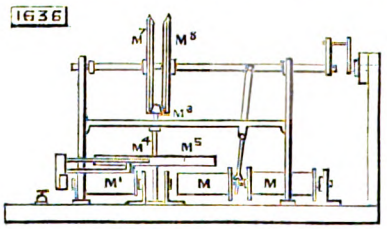
Fig. 1 shows the arrangement for one form of lamp, the peculiarity of which lies in the feeding parts; E is the brake wheel, acted on by a shoe

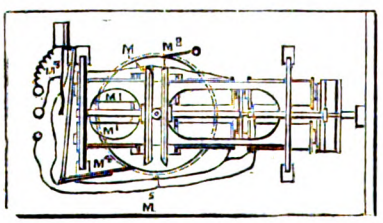


carried by the lever pivotted at F. At the end of F is a coil, opposite to which is another coil, with connections as shown. The action of the coils is counterbalanced by the spring H. These parts together give the feeding action. The lower carbon is fixed to the inside coil of a solenoid as shown.

1636. IMPROVEMENTS IN APPARATUS FOR PRODUCING MOTION BY ELECTRICITY, *G. St. G. Lane Fox.*—14*th April*, 1881. 6*d.*

This relates to apparatus for controlling or regulating the opening of the throttle valve in the engine, or resistances, or commutators, &c. M M are electro-magnets whose circuits are completed when the E.M.F. of the main rises or falls below a given limit. These magnets are connected as shown in Fig. 2, to a third electro magnet M^1. The armature of M^1 carries the spring M^3, which,

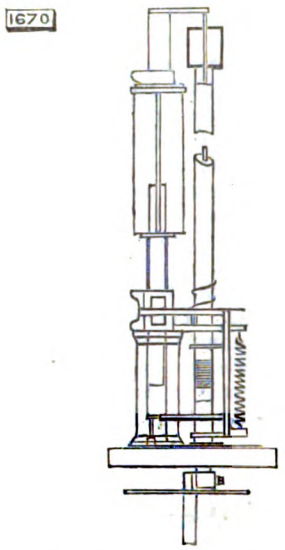




like the hammer of an induction coil, vibrates when the circuit is completed. The armature also carries a pawl M^4 to act on wheel M^5. The rotation of the wheel may be transmitted to the point to be controlled in various ways. The one shown is by a bevel pinion M^6 on shaft of wheel M^5, and two bevels M^7 M^8 on shaft M^9, connected with part to be controlled. The other armature, acted upon by one or other of the magnets M M, causes one or other of wheels M^7 or M^8 to gear with pinion.

1670. IMPROVEMENTS IN ELECTRIC LAMPS, *G. S. Grimston.*—16*th April*, 1881. 6*d.*

The invention relates to the regulation of the carbons by the differential action of two solenoids, and is an improvement on patents granted to C. W. Siemens, Nos. 4,949, 1878, and 2,652, 1879. Instead of regulating the feed of the upper carbon by mechanism the soft iron core, which is acted upon by the two solenoids above referred to, carries an arm, through apertures in which passes the carbon holder—see figure. To the arm is pivotted a cam-shaped piece provided with a projecting arm, the weight of which tends to turn the cam, so as to press the holder against one side of the apertures, the holder being thus held and only allowed to move up and down according as the core is actuated by the solenoids. The upper end of the carbon holder is formed into a tube, which is filled with glycerine, to render its motion smooth. Another part of the invention refers to



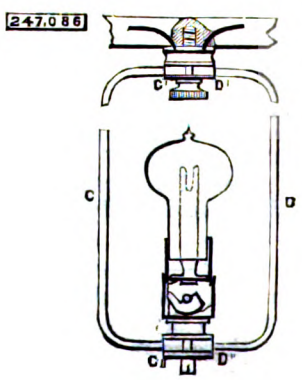
the use of two or more pairs of carbons, of which the upper carbons are all connected to the same holder, so that when one pair is partly consumed the current will on the descent of the holder be transferred to another pair.

1712. IMPROVEMENT IN ODOMETERS, *E. S. Ritchie.*—20*th April*, 1881. 6*d.*

The object of this invention is to measure distances run with bicycles and similar vehicles, the apparatus in the former case being applied to the axle of the wheel, and revolving with it. The apparatus consists of a pair of magnets with their north poles in contact and their south poles also in contact; these are fixed inside a carrier, said carrier being attached to the axle of the wheel. Near the magnets is fixed by its middle a short magnetic needle, and so arranged as to move a train of wheels, the last one of which acts on an index hand. The force of attraction and repulsion of the magnets whilst the bicycle wheel revolves causes the magnetic needle to make one revolution for each revolution of the wheel, and the index hand to mark off on an indicator dial each revolution run.

247,086. CHANDELIER FOR ELECTRIC LAMPS, *Hiram S. Maxim, Brooklyn, assignor to the United States Electric Lighting Company, New York, N.Y.*—*Filed January* 15*th*, 1881.

Claim.—(1) A chandelier or bracket for incandescent lamps the two sides of which are insulated from each other and each connected respectively with one terminal of a line wire and the contact strip of an incandescent lamp, whereby the circuit may be completed through the lamp and the



sides of the bracket frame, substantially as set forth. (2) The chandelier or bracket for electric lamps, consisting of the conducting bars C and D, insulated from each other and having terminal plates C^1 D^1 C^{11} D^{11}, insulated and secured in proper position by means of clamping screws and washers, substantially as shown and described.

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SLIP

ELECTRIC LIGHT IN DUDLEY.—The electric light is shortly to be introduced into Dudley.

THE SWAN LAMP AT WAKEFIELD.—The Swan incandescent lamp is being used to illuminate an exhibition at Wakefield.

TELEGRAPHIC COMMUNICATION WITH TURKEY.—It is announced that a new line of communication with Turkey has been established *viâ* Servia.

THE TELEPHONE IN MANCHESTER.—The Post Office have established a double line of wire for telephonic purposes between Manchester and Liverpool.

TELEPHONE PATENTS.—An interim injunction has been granted against Mr. Alexander M'Lean, of Edinburgh, for infringement of the Bell telephone patent.

DUPLEX TELEGRAPHY IN QUEENSLAND.—News from this colony says that the duplex line between Brisbane and Sydney was working well, and found to be of great use.

ELECTRIC LIGHT AT HAWICK.—Trials with the Swan incandescent lamp have been made in two stocking mills at Hawick, in Scotland, and are reported to have been successful.

PERSONAL.—We understand that Mr. Radcliffe Ward and Mr. W. Wills have resigned their respective positions as engineer and secretary to the British Electric Light Company (Limited).

ROYAL INSTITUTION.—The Christmas course of lectures to be given at this Institution by Professor R. S. Ball, "On the Sun, Moon, and Planets," will be illustrated by means of the electric light.

THE TELEPHONE IN NEW ZEALAND.—The Telegraph Department have established telephonic exchanges in Christchurch and Auckland, and one will probably be started in Dunedin before long.

THE TELEPHONE IN PARIS.—It is stated that M. Cochery, Minister of Posts and Telegraphs, is about to establish telephonic communication between his office and the post offices at Versailles and Rouen.

ELECTRIC LIGHT AT THE AGRICULTURAL HALL.—The Smithfield Club Cattle Show, to be held at the Agricultural Hall, Islington, from the 5th to the 9th of this month, will be lighted by electric light.

ENTERTAINMENTS BY TELEPHONE.—The latest news from France says that a company is to be started to give telephonic concerts. A hall is to be obtained where persons can listen by telephone to either play or opera.

EMPLOYMENT OF CONVICT LABOUR.—A Canadian paper proposes, and no doubt the same idea has crossed many of our readers' minds, to utilise the treadmill to generate electricity for charging secondary batteries.

ELECTRIC LIGHT FOR TRAINS.—Mr. Joseph Pease, M.P., is reported to have stated recently that an offer had been made to light the carriages on the North Eastern Railway by means of electricity at half the cost of the present oil lamps.

ELECTRIC LIGHT AT SELKIRK.—It is reported that Messrs. George Roberts and Co., tweed manufacturers of Selkirk, have resolved to introduce the incandescent electric light into two of their mills. About 300 lights will be used in each mill.

ELECTRIC LIGHT ON SHIPS.—The ss. "India," belonging to the British India Steam Navigation Company, which sailed this week for India, is fitted with Swan's incandescent lamps. She is a ship of 4,065 tons, and was built by Messrs. William Denny and Sons, of Dumbarton.

DIRECT SPANISH CABLE.—The Great Northern Telegraph Company's cable steamer the "H. C. Oersted" has been chartered by the India Rubber, Gutta Percha, and Telegraph Works Company for the purpose of repairing the Direct Spanish Telegraph Company's cable.

A TELEPHONE CLERK CHARGED WITH THEFT.—William Sharp Ross, a clerk employed at Edinburgh by the National Telephone Company, was apprehended on Monday last, on a charge of theft. It is alleged that Ross abstracted from the safe money and documents to the value of £150.

DIRECT SPANISH CABLE.—In the early part of this week the Direct Spanish Telegraph Company announced that their Falmouth-Bilbao Cable was interrrupted, and that the fault was near the Spanish coast. All telegrams are now, therefore, forwarded *viâ* the Eastern Telegraph Company's cable.

INTERNATIONAL TELEPHONE COMPANY.—It is stated that the International Telephone Company have purchased Gramme's patents, and that these are to serve as the basis for the formation of a company, with a capital of 10,000,000f., which the International Telephone Company is going to form.

ELECTRIC LIGHT FOR BLACKHEATH.—The Works and General Purposes Committee of the Lewisham District Board of Works have been deputed to consider the question of employing electric lights to illuminate Blackheath. As this is a large open space it seems to offer peculiar facilities for arc lamps.

TELEGRAPHS IN CHINA.—*The Times* correspondent at Shanghai, writing under date the 12th of October, says:—"I am pleased to be able to note the completion of the new telegraph line between Shanghai and Chinkiang. It is expected that the whole line to Pekin will be in working order before the end of the year."

SECONDARY BATTERIES.—The paper on this subject, by Professor W. G. Adams, which was recently read before the Science Society of King's College, and of which we gave an abstract, can now be had in pamphlet form by applying to the Secretary at King's College, Strand. The price of the pamphlet is sixpence, or by post sixpence halfpenny.

AN ELECTRIC RAILWAY COMPANY.—A company with this title is about to ask Parliament for powers to construct an electric railway in London. We believe the immediate attention of the company will be directed towards connecting Charing Cross with Waterloo Station, and so bringing the South Western Railway to the left bank of the Thames.

THE TELEGRAPH AND THE POLICE.—News from Brighton says that telegraphic communication has been completed between the several police-stations of the town, the Post Office authorities having agreed to provide the wires and the necessary instruments, and maintain them, at an annual rental of £135 5s. for the first seven years, and £91 10s. after that time.

ELECTRIC LIGHT FOR HULL.—At a recent meeting of the Hull Corporation it was resolved to make application to Messrs. Siemens and the Brush Company for estimates for lighting the town within the docks with the incandescent system of lighting for twelve months; also to ascertain whether, if the lighting proved successful, the company would be ready to sell the plant at the end of that period.

HONOURS.—The King of Italy has presented M. Cochery, the French Minister of Posts and Telegraphs, with the Grand Cross of the Order of Saints Maurice and Lazarus; and M. Berger, the Chief Commissioner of the Electrical Exhibition, has been made a Grand Officer of the same Order.

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These honours have been conferred for the services rendered by these gentlemen in connection with the Exhibition.

THE EDINBURGH TOWN COUNCIL AND THE BRUSH ELECTRIC LIGHT.—The Edinburgh Town Council, after resolving to dispense with the Brush electric light as a street illuminant, in consequence of its proclivities to flicker and leave the city "in dim eclipse," at a meeting held on Wednesday last re-resolved to give it another month's trial, at 2¼d. per hour per lamp, the Company agreeing to make certain improvements so as to produce a steadier light.

EASTERN EXTENSION COMPANY.—We understand that the operation of laying the cable specially designed to guard against the ravages of marine insects, manufactured for this company by the Telegraph Construction and Maintenance Company, has been successfully completed. This cable is 536 knots in length, and is laid between Batavia and Singapore. The work of taking up the cable which has thus been replaced is progressing satisfactorily.

ELECTRO-PHOTOGRAPHY.—An exhibition of Muybridge's electro-photographic apparatus by means of which any particular motion of an animal or man can be photographed instantaneously, was given by M. Meissonier, the painter, in his studio at Paris the other day. By means of these photographs the separate and various movements made by a horse in walking, trotting, galloping, &c., can be reproduced, and painters will no longer have to imagine what they were like.

ELECTRIC LIGHTING IN MALTA.—Official permission has just been granted for an experimental illumination of the exterior and interior of the theatre, the Governor's Palace, and the Palace Square at Malta by the Eastern Electric Light and Power Company (Limited), who are the sole licensees of the Brush and Lane-Fox systems for the Island. An engineer with a consignment of machinery left London on Wednesday by the "Mirzapore" to carry out the necessary works.

ELECTRIC LIGHTING AT PARIS.—The Paris Municipal Commission has resolved to illuminate the council hall successively with five different systems of electric light, to determine the price of each system, and make a choice amongst them. The Swan and Brush systems are two of those selected. Electricity will also be used to work an elevator of the kind shown by Clark, Muirhead, and Co., and a printing press. The sum of 75,000 francs has been voted towards the experiment.

THE TRANSMISSION OF MONEY BY TELEGRAPH.—The Postmaster-General has written, in reply to a gentleman who called attention to the fact that money can be transmitted by telegraph in Continental countries, and asked if the system could not be adopted in England, "that, having regard to the facilities already afforded by the existing postal note and money order systems, and to the rapidity with which remittances can be effected through the post, he is of opinion that its introduction into this country is not called for."

PATENTS IN AMERICA.—From the list of patents taken out in the United States Patent Office between January and June of this year, it appears that Edison has taken out 22, of which 17 were connected with electric lighting and dynamo machines, as follow:—Systems of lighting and lamps, 11; carbons for incandescent lamps, 5; dynamo-machine, 1; regulating the generation of currents, 1; the Weber meter and electric meter, 2; telegraph relay, 1; magneto signal apparatus, 1. We believe that more than double this amount of patents have been taken out in England by Edison in the same period.

PROPOSED NAVAL EXHIBITION IN LONDON.—It is proposed to hold a Naval and Submarine Engineering Exhibition in the Agricultural Hall, Islington, in April, 1882. Amongst other things appertaining to naval architecture we notice that it is intended to show electric lights, electro-plating apparatus, batteries, and scientific instruments of different kinds, also models of cable ships, for which a large tank will be provided. Two catalogues are promised, the larger of which will be issued at the close of the exhibition, and will contain an article on "Electric Lighting of Ships." All particulars as to space, &c., can be had of Mr. Sampson Barnett, jun., 4, Westminster-chambers, S.W.

THE RECENT GALE.—Once more a storm of more than usual violence has upset the postal telegraphs in many places. The south-westerly gale of Saturday and Sunday last caused interruptions between London and Scotland, and London and the South Coast, which took some little time to repair. The gale was accompanied by thunder and lightning in several localities, a chimney stack at Hull being struck and knocked down, causing injuries to some boys. From the neighbourhood of Faversham it was reported that the Sittingbourne and Dover mail cart had been upset by coming in contact with a telegraph post and wires, which had been blown across the road, and that the driver was compelled to complete his journey on foot, carrying the mail bags with him.

ROYAL SOCIETY.—On Wednesday, Mr. Spottiswoode delivered his presidential address at the anniversary meeting of this society. Speaking of the Congress and Exhibition at Paris, Mr. Spottiswoode remarked that he thought one point must have struck those who examined any considerable number of the exhibits. Not that he mentioned this in a disparaging way, but rather as illustrating the level to which electrical science had attained. It was that, while the assemblage of instruments, &c., was in every way remarkable, and while very great ingenuity and skill had been expended on their contrivance and construction, yet the amount of novelty in the principles involved was comparatively small. Mr. Spottiswoode's address was a general review of the progress of science in the past year.

LEGAL.—INFRINGEMENT OF PATENT.—Judge Blatchford has given the following decision in the suit for infringement of patent by John H. Irwin and the Western Electric Manufacturing Company against the Metropolitan Telephone and Telegraph Company and another, which was recently tried in the United States Circuit Court at New York. He says:—"I think the proper and necessary construction of claims one and two is that the normal pressure of the electrode must be obtained by means of gravity counteracted partly by a delicate retractile spring, elastic in the direction opposed to gravity. The spring must suspend the needle against the force of gravity. The defendant's instrument does not employ gravity to secure pressure, nor a spring to modify the force of gravity, but it obtains the normal pressure of the electrodes by the direct strain of a flat spring. There is no infringement of claim three. The vibrating disc of the defendants does not have free edges, and is not capable of vibrating bodily in the sense of the patent. In consequence of being held by the spring and the clamp it bends, and some parts between the centre and the edge move more than others. The bill will be dismissed with costs when the case is disposed of as to the American Bell Company."

THE EDISON LIGHT IN THE CITY.—We recently noticed that application had been made to the Commissioners of Sewers by Edison's agent in London, Mr. E. H. Johnson for leave to light Holborn Viaduct with his incandescent

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lamps, free of cost, for two months. This request has been granted by the Commissioners, and the work is to be proceeded with. The lamps will be placed two on each lamp post, replacing present gas burners, but not disturbing them, so that if needed the latter can be lit at once. An office and show rooms have been taken close to the Viaduct, and are being rapidly fitted up with lamps and apparatus. A special chimney shaft has been built up from the basement, right through the roof, and special foundations have been laid down to receive the dynamo machines. Mr. Johnson hopes to have the lights on the Viaduct going by the 15th of this month. Lights will also be supplied to the premises in the immediate neighbourhood of the offices. Dr. Parker's church, the City Temple, is to be lit by 150 lamps; several are to be introduced into the Viaduct Hotel, and so on. It is intended to fit up the show rooms with every description of bracket, standard, methods of conducting the wires to the lamps, &c., in order to show the adaptability of the light to domestic purposes.

Canadian Mutual Telegraph Company.—According to the *Montreal Gazette*, this company, which has been started in opposition to the Jay Gould monopoly, and which has combined with the Eastern Telegraph Company of Maine, the Baltimore and Ohio Railway system, and the Mutual Union Telegraph Company, will control some fifty thousand miles of wire, that being the aggregate of the several companies' systems. The *Gazette* says:—"It is with an American telegraphic system of such wide ramifications that the new Canadian company is allied, and enjoying such great facilities for business with the United States, and through the American companies with Europe, having as it will the support of the public of Canada, promoted as it is by men of capital, of large business experience and of thorough sincerity in the work they have undertaken, there can be no doubt of the success of the Canadian Mutual Telegraph Company. We understand that it is the intention of the new organisation to push forward at once with the greatest possible expedition the work of construction in Canada. It is expected that the lines will be completed *viâ* Montreal as far west as Ottawa this fall, and the company intends to establish telegraphic connection between all important points in Canada next summer." Mr. G. R. Hosmer is the general manager of the new company; for several years past he has been better known as Eastern superintendent of the Dominion Telegraph Company.

The Electric Light and Torpedoes.—Experiments have been made on board H.M.S. "Sultan," at Portsmouth, with the object of testing the applicability of reflected light for search purposes at sea, so that the men in charge of the apparatus should be hidden from the enemy. We take the following account of the apparatus used from *The Times* of a recent date:—"An iron tube, 3ft. 7in. in diameter, or just capable of containing the ordinary-sized lenses, was carried through the forward hatchway, and extending from the lower deck to about a couple of feet above the top of the funnel when housed for safety. The portion of the tube between the main and the lower deck is made portable, so as to enable the lenses and lamp to be adjusted. The lamp, which is one of Professor de Monnier's, is fixed on a vertical slide within the tube between decks, and is consequently so protected as to be impervious to attack. The carbon points are placed obliquely, and are so arranged that they can be revolved to suit different practical conditions. At the bottom of the tube, and below the light, is a plano-concave reflector, while immediately above the light is a dioptric lens; the upper and exposed end of the tube is surmounted by a square iron hood about 4ft. in height. This is made to turn in any direction round the tube upon a roller path, and inside of which is a mirror, 3ft. in breadth and 4ft. in height, and mounted on a pivot, so that by means of gearing it can be made to project the reflected beam from below at any angle of elevation or depression that may be required. The current is generated by the ordinary apparatus with which ships of war are now provided, and which in this case consists of a D Gramme machine driven by a Brotherhood engine. The system seemed perfectly practicable and under control, but further experiments will be made with the object of testing the merits of different lenses."

"The Age of Electricity."—This was the title of a lecture delivered at the City Hall, Glasgow, on the 24th of November, by Mr. W. H. Preece, F.R.S., under the auspices of the Glasgow Science Lectures Association. Sir William Thomson presided, and there was a large audience. Mr. Preece, in the course of an amusing lecture which seemed to be much appreciated, described the present age as the age of electricity, just as the earlier ages had been described as the stone age, the iron age, and the bronze age. He then gave an account of the numerous applications of electricity exhibited at the Paris Exhibition, and said that prior to 1837 there was only one practical application of it, and that was the lightning conductor, whilst within the recollection of nearly everybody all the present applications of electricity had received their birth, and it was impossible to anticipate its future; and yet, if asked what electricity was, he could only scratch his head and say he did not know. If he were to turn round and appeal to the greatest living electrician (Sir William Thomson), he would shake his head in a way only to be equalled by the manner in which a celebrated lawyer nodded. Mr. Preece then explained the production of magnetism, heat, light, and chemical decomposition by means of electricity, and the numerous purposes to which the latter could be applied, both domestic and otherwise. He took his hearers to America, and gave an account of the wonderful development of the use of electricity that has taken place there. Speaking of the telegraph he said that he had seen in Paris a collection of the best telegraphic apparatus in the world. He went there to see if any wrinkles were to be got from our continental friends which would be useful in this country, but he came back without a single one, and with the firm conviction that in telegraphic apparatus and enterprise we were years ahead of everybody else. Wheatstone's automatic apparatus was described, and some instruments in the hall were connected with various places to illustrate their working. The electric light, Mr. Preece said, was no doubt the domestic light of the future, and the day was not far distant when we should have it in our houses, but it would not be introduced at the expense of gas; we should use gas for its proper purpose—the production of heat and energy. The lecture was illustrated with a number of experiments. At the conclusion Sir William Thomson moved a vote of thanks to Mr. Preece, and in the course of his speech said that the future of gas was not to dwindle away before the electric light, but to do the work at present done by steam. The steam engine was passing away, and the gas engine would supply its place. It was a much more economical motor, and sad as it was for Glasgow people, with their associations of James Watt, they must look forward to the time when, instead of getting up steam, fire would be applied direct to do the work. We regret that pressure on our space precludes our doing more than very briefly summarising Mr. Preece's lecture.

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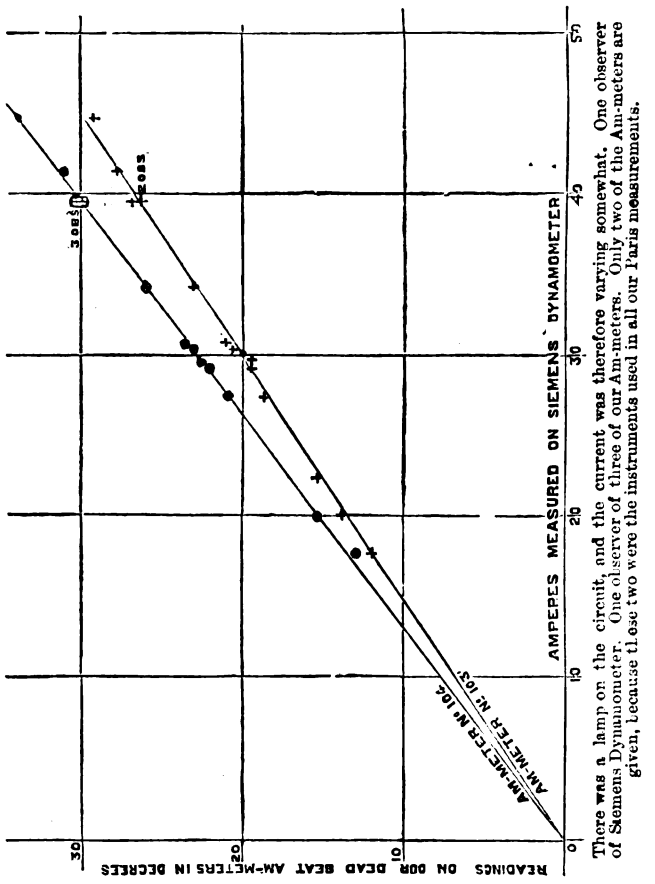
THE EFFICIENCY OF ELECTRIC LAMPS.

BY PROFESSORS AYRTON AND PERRY.

(Reprinted from the *Engineer*.)

In accordance with your request, we send you a report on the efficiency of a few of the more important systems of electric lighting exhibited in the Paris Exhibition. Any system of electric lighting must consist of three parts—the engine producing the mechanical power, the electric machine for converting the power into electric energy, and thirdly, the lamp for converting the electric energy into light. Until the commencement of last winter the distinct purposes of these three machines were rarely separated one from the other in any experiments made on electric lighting. As a rule, the horse-power developed by the engine was simply measured from an indicator diagram, and the light given out by some sort of photometer; but when a small number of candles per horse-power was obtained it was very difficult to say whether this was due to friction in the engine or shafting connecting the engine with the dynamo-machine, or due to imperfections in the dynamo-machine itself, or, lastly, to the fault of the special system of lamp employed for converting the electric power into light. It therefore appeared to us desirable in all experiments on the economy of electric lighting to distinguish between the performance of the three distinct parts of the apparatus employed in producing the light.

To measure the efficiency of the dynamo-machine as distinguished from that of the engine, it is necessary by means of a transmission dynamometer to ascertain the amount of power given by the engine to the dynamo-machine, and, in addition, the current produced by the dynamo-machine through known resistances. Such experiments have been made by Mr. Schwendler, Dr. Hopkinson, and others, and the results will be found in the published accounts of their investigations.



There was a lamp on the circuit, and the current was therefore varying somewhat. One observer of Siemens Dynamometer. One observer of three of our Am-meters. Only two of the Am-meters are given, because these two were the instruments used in all our Paris measurements.

But a complete measurement of the efficiency of an electric lamp can be made without any reference whatever to the amount of work given by the engine to the dynamo, or to the goodness or badness of either of the latter, exactly as experiments can be made on the efficiency of a gas burner without considering whether the company's mode of making the gas is good; or on the efficiency of a turbine attached to the water pipes of a house, without any inquiry as to whether the pumps employed by the company at their works are good or bad. To measure the efficiency of a turbine it would, of course, be only necessary to ascertain the quantity of water used or passed through it in any time, together with the loss of head and the amount of mechanical work given out by the turbine during the same time. So in the same way the efficiency of any instrument for converting electric energy into any other form of energy can be ascertained. For example, if we desire to measure the efficiency of an electro-motor, or machine for converting electric energy into mechanical work, we have to measure the current in Ampères* passing through it, and the electromotive force in Volts maintained between its two terminals. The products of these two multiplied by 0·00134 gives the horse-power expended in the machine. Part of this will be wasted in heating the wires in the motor, part in overcoming mechanical friction, and the remainder, which may be measured by a force dynamometer, can be employed in doing useful work.

Such experiments—which, it must be remembered, are wholly independent of the goodness or badness of the mode of generating the electric current, or of the amount of heat produced in the wires connecting the electro-motor with the generator—have been made by our students during the last twelve months on a magneto-electric Gramme machine, running at different speeds, with various loads.

In the same way, if it be desired to measure the efficiency of an electric lamp, it is merely necessary to measure the current in Ampères passing through it, and the difference of potentials in Volts between the terminals of the lamp. The product of these two, as before, multiplied by 0·00134, gives the horse-power actually expended in the lamp, quite independently of the horse-power actually employed in generating the current. With the horse-power expended in the lamp must be compared the simultaneous illuminating power of the lamp in standard candles, and thus we arrive at the number of candles per horse-power expended in the lamp itself.

Such experiments, also, our students have been engaged at during the last twelve months with a Duboscq-Foucault and with a Serrin lamp, with different strengths of current, and with different fixed distances between the carbons; as well as, during the spring of this year, with incandescent lamps; and a sample of the results is given in Table I.

In making such experiments it is of great importance to be able to measure both current and electromotive force rapidly with accurracy, so that all sudden changes may be recorded. For this purpose we have devised a dead-beat galvanometer, which measures the strength of the current directly in Ampères, but which can be calibrated by the use of a single Daniell cell. This instruemnt—which we have called an Ampère-meter, or, for simplicity, an "Am-meter"—will be found described in the *Journal of the Society of Telegraph Engineers*, No. 36, Vol. X., 1881.

The proportionality of the deflections of our Am-meter with current may be easily tested, without the necessity of using strong currents, by turning the commutator to series, since of course the relative values of the deflections must be the same for the instrument in series as in parallel circuit. As a check to this, however, we thought it well at Paris to place three of our Am-meters in circuit with a Siemens dynamometer on an electric light circuit, and the curves above, or rather straight lines, show the results obtained with Nos. 103 and 104 used by us in our Paris measurements, the actual numbers being given in the following table. Horizontal distances represent Ampères as measured on Siemens' dynamometer, and vertical distances the deflections in degrees on our two Am-meters respectively. The points corresponding with the third Am-meter are also in a straight line, but are not shown in the figure, as the instrument was not used by us in the experiments at Paris. It will thus be seen that not only can measurements be made of varying currents easily with our instrument on account of its dead-beat character, but that the deflections in degrees, at any rate for currents up to 50 Ampères, the strongest measured by us at Paris, are directly proportional to the current.

COMPARISON OF TWO AM-METERS MADE AT THE OFFICE OF MESSRS. ROWATT AND FYFFE AT THE PARIS EXHIBITION.

Am-meter No. 103. Deflection in degrees.	Am-meter No. 104. Deflection in degrees.	Siemens' dynamometer Ampères.
27·4	31	41·18
29·4	34	44·83
26·9	30·1	39·68
26·4	30·2	39·68
21·0	23·6	30·73
19·4	22	29·20
26·4	30	39·7
20·4	24	—
19·4	22·6	29·57
20·4	23	30·93
18·4	21	27·5
11·6	12·4	17·74
13·4	15	20
14·9	—	22·43
22·7	25·8	34·97

We were not in a position to get any current we pleased, as our circuit contained electric lamps and a dynamo machine. The less intense currents in the table were rather fluctuating, and as the Siemens dynamometer is not meant to measure varying currents, the consistency of the numbers is even more than could have been expected.

We have also constructed a dead-beat "Voltmeter," which, although it measures even large electromotive forces, can also be calibrated by the employment of a single Daniell cell. A third instrument, an "Electric Power Meter," we have also designed to measure directly the product of the current into the electromotive force—that is, the horse-power—and which can be used in place of the other two instruments when only the horse-power expended in an electric circuit is required. This instrument—which, like the two previous ones, differs from all other instruments previously designed, in that the calibration can be effected with much smaller powers than it is required to measure—will be found shortly described in a lecture delivered on the 24th March of this year, at the Society of Arts, as well as a dispersion photometer, arranged by us to measure even strong electric lights in a small space, and which has been employed by us, conjointly with other photometers, in the experiments contained in this report.

The special form of our dispersion photometer, which we employed at Paris, is shown in the engraving on page 38. It consists of a wooden box, A B, to which is joined a wooden tube, B C, the joint being covered over with soft black cloth, to prevent extraneous light entering the photometer; A B contains the standard candle, for which D is the

* "Ampère" is the new name given by the International Electrical Congress to the practical unit of current, formerly called in England by proper consent a "Weber." The change was made, or rather the popular name was not authoritatively adopted, because Professor Helmholtz pointed out that in Germany the word Weber was used for a unit of current only one-tenth of the practical English unit.

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chimney. This candle illuminates a screen of tracing paper, while an exactly similar screen, cut from the same sheet of paper, is illuminated by a beam of the electric light passing down the wooden tube B C, and dispersed in passing through the thin double concave lens at H. The two pieces of tracing paper are, by means of mirrors, placed at exactly the same angle, reflected so as each to cover half the opening B, care being taken to avoid parallax by placing the head so that the intersection of the two mirrors is exactly in the centre of the opening. The wooden tube B C can, by means of the jointed rod E F, be placed at any angle with the horizon, so as to receive a beam from the electric light at any specified angle. When using the instrument the tube B C is pointed at the electric light, so that the axis of the tuble appears to pass through the arc itself. The concave dispersing lens is now moved parallel to itself along the tube by turning the handle H, until the illumination of the two screens is equal, the hole at B being closed by either the red or the green glass respectively. The intensity of the light in candles is then read off directly from the position on the scale of the pointer moving with H. It will be observed that there are three such scales passed over by the same pointer, the bottom one

TABLE II.

Experiments on Some Electric Lights in the Paris Exhibition. All lights measured horizontally.

NAME.	E.M.F. in Volts between the 2 terminals of lamp.	Current in Ampères flowing through lamp.	Horse-power expended in lamp.	Candle-power. Green.	Candle-power. Red.	Candles per horse-power. Green.	Candles per horse-power. Red.	Mean candles per horse-power.
Crompton	37·7	25	1·26	2916	1849	2314	1467	1890
Joel, semi-incandescent...	6·6	44·2	0·39	70	60	179	154	166
,, ...	7·1	45·0	0·43	75	70	174	163	168
,, ...	6·6	50·0	0·44	75	68	170	155	162
Pilsen	36·8	10·33	0·48	780	512	1625	1066	1345
Brush	38	10	0·51	2025	961	3970	1884	2427
Santier - Lemonnier. One lamp on A Gramme Machine.....	40	43	2·3	15376	5625	6685	2446	4565
Ditto	45	42	2·54	15376	9025	6054	3553	4803
Maxim incandescent.....	53·6	3·32	0·24	135	120	562	500	531
Maikoff	45·3	8·3	0·50	397	307	794	614	704
Santier - Lemonnier. One of ten lamps on H Gramme machine.....	40	12·5	0·67	540	310	806	463	634
,,	46·6	9·2	0·58	*784	125	1170	187	678
Gravier	31·1	35·8	1·49	1023	349	1173	604	1189
Serrin	51·8	16·7	1·16	2448	938	1616	630	1123
Cance	33·7	21·7	0·98	3445	1156	2970	997	1983
Weston	73	2·5	0·244	2663	1024	2717	1045	1881
Maxim incandescent.....	77	2·8	0·294	350	290	1434	1189	1311
	77	2·8	0·294	270	262	934	886	910
	81·3	2·8	0·305	350	350	1211	1211	1211
	85·3	3·3	0·377	422	350	1383	1148	1285
Engine and dynamo machine running at higher and higher speeds.	88	3·6	0·424	512	360	1358	954	1156
	105·5	4·6	0·650	678		2050		
				1225		1883		
				†1370				

* This measurement of light was made on Rumford's method. † This lamp now broke.

TABLE I.

Nature of Lamp.	No. of cells.	Method of measuring light.	Strength of light. Red.	Strength of light. Green.	Ampères.	Volts.	Horse-power.	Candles per horse-power. Red.	Candles per horse-power. Green.	DATE.
Swan	20	Bouguer's.....	8·5	—	1·22	31·1	·052	162	—	May, 1881.
,, ...	25	,, ...	23·6	—	1·57	41·4	·087	276	—	
,, ...	30	,, ...	39·1	—	1·78	47·5	·119	338	—	
,, ...	20	Rumford's ...	3·1	—	1·47	31	·06	51	—	October, 1881.
,, ...	25	,, ...	12·7	15·4	1·75	37	·087	146	177	
,, ...	30	,, ...	30·8	41·5	2·10	42·5	·12	257	346	
,, ...	40	,, ...	132	—	2·8	58·8	·22	544	—	
Maxim ...	20	,, ...	0·25	—	1·2	31·5	·05	5	—	
,, ...	25	,, ...	2·6	—	1·5	38	·07	35	—	
,, ...	30	,, ...	6·8	—	1·8	46·7	·11	62	—	
,, ...	40	,, ...	26·3	31	2·3	61·2	·19	138	163	
,, ...	48	,, ...	87	105	2·8	67	·25	348	420	

TABLE III.

Foucault-Duboscq Lamps worked with Grove's Cells, City and Guilds of London Technical College, Finsbury, October, 1881.

Ayrton and Perry's Photometer. 55in. from lamp. Candle-power. Red.	Ayrton and Perry's Photometer. 55in. from lamp. Candle-power. Green.	Rumford's method. D = 207in. d. in inches Red.	Rumford's method. D = 207in. d. in inches Green.	Rumford's method. Candle-power. Red.	Rumford's method. Candle-power. Green.	Ratio of lens method to Rumford's method. Red.	Ratio of lens method to Rumford's method. Green.	Mean Red.	Mean Green.	Ampères.	Volts.	Horse-power.	Candles for 1-horse power. Red.	Candles for 1-horse power. Green.	REMARKS.
121	—	18·3	—	127	—	0·9	—	125	—	9·4	30·5	·38	326	—	Observers change places.
—	207	—	15·6	—	176	—	1·1	—	192	9·4	30·5	·38	—	500	
121	—	17·6	—	136	—	0·9	—	128	—	9·4	28·1	·35	365	—	
—	201	—	15·1	—	184	—	1·1	—	194	9·2	29·8	·37	—	524	
108	—	19	—	116	—	0·9	—	112	—	9·2	28·1	·35	320	—	Observers change places.
—	210	—	14	—	216	—	1·0	—	213	9·8	28·1	·37	—	575	
158	—	15·9	—	169	—	0·9	—	163	—	9·8	46·8	·61	267	—	Observers change places.
—	334	—	12·7	—	282	—	1·3	—	298	12·6	33·6	·57	—	522	
190	—	16·25	—	161	—	1·2	—	175	—	7·7	52·1	·54	324	—	
—	256	—	13·2	—	243	—	1·0	—	249	12·6	32·9	·56	—	444	
132	—	17·25	—	144	—	0·9	—	138	—	12·6	32·9	·56	246	—	Observers change places.
166	—	15·7	—	171	—	1·0	—	168	—	12·6	32·4	·55	305	—	
—	196	—	13	—	252	—	0·8	—	224	12·6	31·2	·53	—	422	
					means	0·95	1·05								

The direction of the light was nearly the same to the two photometers.

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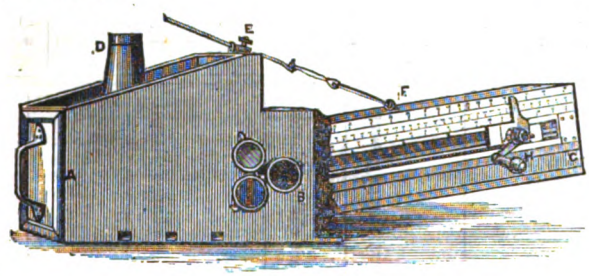
is used when the light is comparatively weak, and when it is 1½ft. from the end of the photometer, the middle scale when the light is stronger and requires that the end of the photometer shall be 3ft. away from it; and lastly, the top scale for the strongest lights when the end of the photometer and the light are placed at 5ft. distance. The numbers on each scale overlap one another—that is, a light which is so strong or so weak as to require the pointer to be put near one or other ends of one of the scales can be also measured on one of the other scales. The handle H gives motion to the lens by causing a pinion to run along a rack, a plate, shown in the figure, running between two guide rods preventing any turning of the lens and the slot in which the pin attached to the lens frame runs being closed by two india rubber tubes, so that no extraneous light can enter. The above, it will be seen, is the application of our dispersive principle to the Bourguer photometer. We originally adopted the Bourguer plan of two screens, one illuminated by the candle, and the other by the electric light, because this apparently furnished the only simple means of arranging a photometer by which a beam of light at any angle could be measured. We have since, however, adapted our lens dispersing principle to the Rumford shadow method, and by a special arrangement of one mirror turning on an axis inclined to its plane, we are enabled to measure light coming at any angle from the lamp without introducing the error that would arise from variations in reflecting power if the light were reflected from the mirror at different angles.

This form of our dispersion photometer which we are using now we find extremely convenient, as the motion of the lens supplies a coarse adjustment, and that of the candle a fine adjustment, and the whole instrument can be employed quite close to even very strong electric lights.

As in the following experiments, it was desirable to know not merely the horse-power expended in the lamp, but also the current and electromotive force, we employed two separate instruments rather than our Electric Power Meter. Not having one of our own Voltmeters for our measurements—the demand for these instruments being greater than the supply—M. Deprez was kind enough to lend us a dead beat galvanometer of 110 ohms resistance, and as this did not offer enough resistance to act alone as a shunt to an electric lamp, an additional resistance, varied in different experiments, was added. Actully, therefore, we employed one of our Ammeters to measure the current passing through the light, M. Deprez's galvanometer with a resistance box to measure the electromotive force, and one of our dispersion photometers to simultaneously measure the intensity of the light.



DISPERSION PHOTOMETER.

When making a measurement the main circuit was momentarily interrupted by disconnecting one of the leading wires from the electric lamp to be tested and placing our Am-meter, to which two thick wires were attached, directly in circuit. The terminal of the Am-meter which was connected with the lamp was permanently in connection with one terminal of the high resistance galvanometer, the other terminal of the latter being permanently connected with one end of a resistance box. A comparatively thin wire attached to the other end of the resistance box was connected with the other binding screw of the lamp, so that the galvanometer and resistance acted as a shunt to the lamp, and thus the current passing through it measured the difference of potentials between the terminals of the lamp.

It will be observed from our table that we always give two measures of the strength of the electric light, as compared with that of a standard candle. One of these is the measurement when the two lights compared are seen through green glass, and the other when they are seen through red glass. It seems to us a very difficult matter to say what is the meaning of the strength of a light in terms of another light which is of a totally different colour, and although there is no doubt that the electric light and a candle are quite different in colour, the intensity of one is constantly expressed in terms of the other without reference to colour. If, then, while awaiting the adoption of a better standard than a candle, the intensity of the electric light is to be measured in terms of that of a standard candle, it has seemed to us that the only method of comparison that can be employed without elaborate spectroscopic observations, is that of comparing the amounts of two very different kinds of monochromatic light in each.

The measurements given in Table No. II. occupied five evenings, not on account of any delay in carriage of our measuring apparatus from place to place in the Exhibition, since the three instruments employed could easily be carried by ourselves, but because so much time was necessary to persuade the owners of the various systems of electric lighting into giving us permission to make the measurements, even although, in order to economise time, we tried to obtain such permission during the day.

There are some other observations which showed a certain amount of inconsistency with one another and with the results given in this table, and which are not here given as they will be referred to further on. A column might have been added giving the value of the ratio of the electromotive force to the current, and which would represent the resistance of the arc were there no opposing electromotive force; but as there is no simple means of measuring how much of the opposition in a light to the current is due to resistance, and how much to an opposing electromotive force, we did not wish it to be inferred from our giving such a table that we regarded it as all due to the resistance.

Of course, it must be carefully remembered that the last column headed "Candles per Horse-power" means per horse-power actually expended in the lamp. It is much more usual to state candles per horse-power expended in the engine, and as the efficiency of the best generators is about 80 per cent., and as in the case of a dynamo some portion of the work—which in an ordinary Gramme and Siemens machine is about one half—is wasted in heating the coils of the machine itself, it may usually be assumed that upwards of 2½ horse-power is expended in the engine for every horse-power actually expended in the lamps themselves.

We do not consider that the last column, "Mean Candles per Horse-power," has any physical meaning, and we have merely added it because people have not yet acquired the habit of separating the two monochromatic measurements from one another. To persons who have not used our photometer, it may be necessary to say that our measurements will, as a rule, be found greater than those given by Rumford's method, or by any simple distance method of measuring. At first sight, this seems to point to a defect in our photometer, and we regarded it in this light for some time, but after a very exhaustive examination of the possible sources of error in the use of our instrument, we have come to the conclusion that it is not our measurements that are wrong, but that Rumford's and other direct methods, which are usually supposed to be perfect, may really give incorrect results.

An examination of Table III., which gives the results of experiments made by both methods on a Foucault-Duboscq lamp worked by Grove cells, will show that when the light examined is weak, there is no great difference in the answers given by the two methods.

(TO BE CONTINUED).

THE STORAGE OF ELECTRICITY.*

By SYLVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

(Continued from page 23.)

IMPORTANCE OF SUFFICIENT CURRENT DENSITY.

The influence on the polarisation force of a cell of the size of the plates used as electrodes relatively to the strength of the charging current has also been investigated by several experimenters, amongst them Crova, Poggendorff, and Bunsen, and more recently by Bartoli and Blondlot. It is found that the degree to which a counter-electromotive force or polarisation force is set up depends very greatly on the quantity of current per unit of surface of the electrodes employed. If the current be weak, and the electrodes large, the polarisation never reaches its maximum. On the other hand, if the electrodes be of very small surface, and the current a strong one, the polarisation may attain abnormally high values. Thus Buff, electrolysing water with small platinum points, found the counter-electromotive force to be no less than 3·57 volts. This difference between this and the minimum value of about 1·493, must be accounted for by the fact that the state of the liberated products varies with the condition of liberation. With greater "current density"† the gasses liberated by decomposing water are no longer simple oxygen and simple hydrogen. With greater current-density, a greater proportion of the oxygen comes off in the more highly electro-negative condition of ozone, and more peroxide of hydrogen forms also round the anode, whilst at the cathode, the hydrogen which is evolved possesses in unusual degree the active properties attributed by chemists to "nascent" hydrogen; that is to say, a larger propertion of it probably is, at the moment of liberation, in some abnormal allotropic condition, bearing the same kind of relation to ordinary hydrogen as ozone bears to oxygen. The allotropic hydrogen is more oxidisable; the ozone more ready to oxidise. Their union would evolve more heat than the union of equal weights of ordinary hydrogen and ordinary oxygen. It requires greater electromotive force to keep them apart; their own tendency to unite is greater. J. Thomsen has even measured the heat value of ozone as compared with oxygen, and it takes its place in our table of elements at the bottom below the peroxides, though chlorine and the haloids would be still lower on the list if they came within the scope of present considerations.

It follows from the above argument that if we wish to make our storing cells exert their highest possible reaction, we must store them, using a current whose strength (or quantity) is proportioned to the size of the cell. If we use too weak a current the maximum polarisation, and therefore the maximum efficiency, will never be attained. The current-density‡ is a most important consideration, especially in the early stages of the formation of the cells. It certainly should not be less than 50 milliwebers per square centimetre of surface in the cell.

EFFECT OF STATE OF SURFACE.

Again, the state of the surface of the electrodes has much to do in determining the state in which the gases are liberated, and the resulting polarisation force. Svanberg, in electrolysing water with copper elec-

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* A Paper read before the Society of Arts, Wednesday, Nov. 23, 1881.

† This term means "the amount of current per unit of surface of the electrodes," and is calculated for either electrode (in the simple case of parallel plates) by dividing the total strength of the current in webers (*ampères*) by the area of that electrode in square centimetres.

‡ Crova and more recently Bartoli have given exact formulæ by which to express this important relation. Let P represent the E.M.F. of polarisation at any time; it can be expressed as a function of the possible maximum polarisation and of the density of the current. Let A be this possible maximum E.M.F.; s = the surface (supposed uniform), q the quantity of electricity conveyed in the time t (supposed short), then

$$P = A\left(1 - 10^{-a\frac{q}{s}}\right)$$

where a is a constant (8,400 circ.) This may be interpreted as follows:—The polarisation falls short of its possible maximum by an amount the logarithm of which is inversely proportional to the current density.

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trodes, found the polarisation to be ·72 volts with smooth plates, and only ·47 with corrugated plates. Poggendorff, using platinum plates, found the maximum polarisation to be—with bright surfaces, from 2·28 to 2·50 volts; while with surfaces platinised, *i.e.*, coated with a black, powdery deposit of platinum, the polarisation in cells, like those of Planté and Faure, where the original surfaces of the plates of lead are coated with thick films of peroxide, or of reduced metal, these considerations do not apply, except for the first operation of charging. Indeed, I have found, experimentally, that there is a gain in scratching the leaden surfaces before forming the coating of peroxide; the coating is more adherent, and the effective surface somewhat greater—advantages beside which the greater preliminary waste of liberated gases on first charging is comparatively trivial.

We will next take a brief historical glance at the various stages in the invention and perfection of accumulators or storage batteries.

Professor Thompson then gave a short historical sketch of the development of secondary batteries. He then mentioned at greater length

Ritter's Secondary Pile.

Ritter discovered the possibility of secondary voltaic action while studying the chemical action of electric currents upon liquids. He employed a large voltaic pile as his source of electricity, and observed not only the decomposition of water into oxygen and hydrogen but the phenomena of formation of peroxides, and of the deposition of metallic films at the anode and cathode respectively when metallic solutions were employed. He found that his gold wires, after becoming covered respectively with films of separated oxygen and hydrogen, could set up violent contractions in a frog's leg. He further investigated the phenomenon with different kinds of wires, and found platinum to yield the best result, gold coming next in order, then silver, copper, and bismuth. With lead, zinc, and tin, however, he obtained no result. He further showed that even after having been removed from the water and dried the pair of gold wires retained their activity, and when afterwards plunged into water yielded a current in a direction opposed to that of the pile by which they were originally rendered active.

One remarkable experiment of Ritter's found its way into English journals. Ritter took a *louis d'or*, and placing moistened cloth against its two sides, proceeded to pass through this combination a current from a powerful pile. The coin, still laid in its wrappings, was afterwards found capable of furnishing a current. This led Ritter to propound the view that conductors of electricity, such as the metals, could be charged with electricity; the coin between its metal wrappings being, according to him, the analogon of the Leyden jar lying between its two coatings of tinfoil. He mentions also mercury, carbon, graphite, and binoxide of manganese, as being capable of receiving galvanic charges. "Each of these bodies," he says, "becomes charged upon both its sides just like the glass of the Leyden jar, and this state of charge, when it exists in such concentration or intensity as in the foregoing bodies is perceived as a state of oxygenation on one side, and a state of hydrogenisation on the other."

Progress in Electro-Chemical Knowledge.

The researches of Davy, De la Rive, and of Faraday, upon the chemical phenomena of the voltaic cell, showed that the chemical decompositions within the battery were amenable to the same laws as those which took place in an electrolytic cell at a distant point of the circuit. Faraday brought out several most valuable points in his "Experimental Researches." He describes (Art. 750) how in electrolysing acetate of lead, "in place of oxygen, or even the gases already described, peroxide of lead now appears at the positive,* and lead itself at the negative pole." In his argument for the chemical theory of the cell he remarks that while those substances are highly electro-negative which cannot be oxydised, there is another class of substances still more highly electro-negative, namely, those substances which readily give up oxygen, the peroxide of manganese being more negative than platinum, as Volta showed, and the peroxide of lead being still more negative than that of manganese as Munck of Rosenchöld had shown. Faraday remarked (Art. 1822) on the good conducting power of the peroxide of lead. He also observed that red lead is more negative than platinum. De la Rive, indeed, utilised the strong electro-negative property of peroxide of lead in the construction of a cell in which this substance, packed in a porous pot around a platinum strip, served as one pole, zinc being the other. Niaudet, in his treatise on the "Pile Electrique" (published 1878), suggests that red lead (minium) would have answered equally well. In the Bakerian lecture for 1843, Wheatstone announced that he had measured the electromotive force of peroxide of lead against zinc, and had found it to be 2·266 of that of a Daniell cell (= 2·448 volts).

Grove's Gas Battery.

In 1842, Sir William (then Professor) Grove described the well-known gas battery, which was indeed nothing else than a reversible oxygen and hydrogen battery, in which work had first to be done to produce chemical decomposition, electric currents being passed through acidulated water from one platinum pole to another, these currents being of sufficient power to overcome the opposing mutual affinity of the constituent gases, the reaction of these separated gases tending to produce a counter-current of considerable power, and manifesting a so-called electromotive force of polarisation.

The rationale of the gas battery is simple enough, provided it be once understood that platinum possesses a power, almost unique amongst the metals, of absorbing upon its surface both oxygen and hydrogen gas. When a current is passed between platinum electrodes in acidulated water, the two gases not only rise in bubbles, but form a film at or in the surface of the metal, which when so charged behaves differently from neutral clean platinum. The hydrogenised film resembles zinc or some oxidisable metal, and exercises toward clear platinum, and *a fortiori* toward oxygenised platinum, a strong electromotive force. The energy spent by the decomposing current in separating these gases is stored in the gases that are thus separated. In their subsequent reunion, the energy of their separation runs down into some other form; into heat if the gases are merely mixed and exploded together; into the energy of electric currents if the gases are suffered to recombine through the liquid, by the slower and cooler process of slow chemical combination in the cell.

Planté's Secondary Batteries.

M. Gaston Planté, to whom, more than to any other experimenter, the real advances in the practical construction of storage batteries is due, very carefully re-examined the whole question of the polarisation of electrodes, using different metals as electrodes, and different liquids as electrolytes, and found that the greatest effective polarisation was produced when dilute sulphuric acid was electrolysed between electrodes of lead.

M. Planté endeavoured instead to find the best means of provoking the phenomenon of polarisation, in order to turn to profit the secondary currents and to accumulate the energy of the battery. He was, therefore, led by his preliminary researches in 1860 to construct a secondary battery consisting of nine cells, in each of which two long and wide strips of lead, separated by coarse cloth, were rolled together in a spiral form, and immersed in dilute sulphuric acid. A few months later he modified this form by placing side by side in a rectangular box two series of lead plates, alternately connected together, each plate being about eight inches long and nine inches high. He recurred afterwards to the spiral form as being more convenient, but replacing the coarse cloth by narrow strips of gutta percha.

But the cells thus constructed were not ready for immediate action. Two clean lead plates give no current of their own; they are only intended to receive and store up what is sent into them from some external source. And at first, while the lead is bright, when a current is sent through the cell from some suitable source, such as two or three Grove or Bunsen cells, the separated oxygen and hydrogen gases bubble up to the surface, for the most part, leaving only a very small per centage as an adherent film, and, in consequence, yielding only very transient secondary currents. The plate of lead by which the current enters is, however, attacked by the oxygen, and becomes covered by a thin layer of brown peroxide of lead, and this film, though thin, is powerfully electro-negative toward metallic lead, and toward the film of hydrogen on the cathode plate. The cell in this condition will therefore produce a current, and in so doing the peroxide is partially reduced to the metallic condition, and assumes in its reduction a spongy, or loosely crystalline texture. If now the cell be again charged, and charged in the opposite direction, the other plate of lead becomes, in like manner, peroxidised, while the hydrogen bubbles are less freely evolved, for the atoms of gas unite as fast as they are liberated with the oxygen of the peroxide, and reduce it to the metallic condition. Every time the charging current is thus reversed, the films of peroxide, or of spongy metal, become thicker until the lead to a considerable depth is bitten into. And every such operation increases, therefore, the power of the cell to store up in this electro-chemical fashion the energy of the currents sent into it. M. Planté, who minutely describes the process of "forming" the cell, compares it to a sort of electro-chemical tanning. The first day, the alternate charging should be done at intervals of a quarter of an hour, the cell being discharged between each operation. The next day, the duration of the alternate charges may be increased from a quarter of an hour to a whole hour; the day after to two hours. After repose for a week or a fortnight the charges may last several hours, and by the end of several months the cell will be well "formed;" after which it should, when used, be charged in one direction only, otherwise the whole thickness of the lead plates will be bitten into and transformed into peroxide.

The electromotive force thus developed in a fully charged Planté cell may be as much as 2·38 or even 2·7 volts; and as the large area and close proximity of the plates diminishes the resistance of the liquid to a very small quantity, such cells are capable of furnishing a very powerful current* for a few minutes, and their calorific power is considerable; in fact, they discharge themselves too well, and run down too soon for many purposes. A single cell 10 inches high will, however, suffice to keep a platinum wire 2 inches in length and 1-100 inch in diameter glowing at a bright red heat for three-quarters of an hour. M. Planté states that voltametric measurements show that of the whole current 88 to 89 per cent. is given back by the cell. According to M. Géraldy, a Planté cell containing 1·445 kilogrammes of lead can store 4,983 kilogrammètres of energy, being at the rate of 3,450 kilogrammètres per kilogramme, or 11,329 foot-pounds per pound.

Professor Thompson now referred to the applications of Planté's accumulator for cautery purposes, in telegraphy, electric lighting, on railways, &c., &c.

* Professor Adams, commenting on this observation of Faraday's, shows that Faraday thus anticipated Planté in the discovery of the leaden cell. But a Planté cell filled with acetate of lead is almost useless. The fact that peroxides are thus deposited on the anode was thus discovered before Faraday's researches by Nobili, who noticed also the beautiful iridescent colours in the rings of peroxide films deposited on an anode plate opposite a pointed cathode; the phenomenon known usually as *Nobili's* rings.

* The E.M.F. being 2·38 volts, and the resistance as small as from 0·12 to 0·48 ohm, the current through a short stout wire may be considerably over 20 webers (*ampères*).

(TO BE CONTINUED.)

The Maxim Light at Edinburgh.—A series of experiments with the Maxim electric light was begun on Monday in one of the sorting galleries of the Edinburgh General Post Office. All in the Scottish metropolis who have had an opportunity of viewing this system of illumination, express themselves in laudatory terms, and the officials declare that the services of the doctor will be more seldom required in future. The engine employed is one of Hornsby's, of 20 horse-power, with improved governors, and 43 Maxim lights replace 120 gas burners. The arrangements, which are most complete, have been carried out under the direction of Mr. F. G. Fletcher, of London.

Porcelain Manufacture.—Electro-magnets are made use of in certain French porcelain works to remove small particles of iron which find their way into the paste out of which the porcelain is manufactured, and which prevent the attainment of the pure white colour desired, giving the porcelain when baked a spotty appearance. The paste in a liquid state is made to enter the upper part of a thin box placed between the poles of a horizontal electro-magnet connected with a Gramme machine. As the paste enters it is deflected towards the sides of the magnet by a bent piece of zinc, and the particles of iron arrested.

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THE ELECTRICAL EXHIBITION AT PARIS.

On another page we give some account of a report read by Sir Charles Bright and Professor D. E. Hughes, F.R.S., before the Society of Telegraph Engineers and Electricians at their last meeting, on the Paris Electrical Exhibition, and the occasion is fitting for a few farewell words on that remarkable display of electrical appliances. Exhibitors there are now busy packing up their wares, some for transport homewards to all points of the compass, and others to the forthcoming exhibition at the Crystal Palace. It will be seen from the list of persons who have applied for space at the Palace, given in our issue of last week, that the approaching exhibition will be no unworthy successor of its great forerunner. It will not, indeed, possess the *prestige* of the Paris Exposition, nor will it comprise so many priceless relics of the past, or so great a variety of new contrivances; but, for all that, it will, we are sure, prove both instructive and beneficial.

From first to last, if we except a few weeks at the beginning while the apparatus was being properly installed, the Exhibition at Paris was a great success, and public interest in it, on the whole, continued almost unabated. Towards the latter end the foreign exhibitors, and among them the English, became somewhat tired of having to remain so long away from home, and the proposal of the French Government to postpone the closure beyond the time originally specified, the 15th of November, was met with considerable murmuring; but the fact that the last two days of the extension were to be dedicated to the service of the poorer classes, to give them an opportunity of seeing the exhibition free of charge, helped to make them yield to the official proposal with a good grace. The English exhibitors are one and all indebted to the untiring energy of their Commissioners, Lord Crawford, Sir Charles Bright, Professor Hughes, and Colonel Webber; and their especial thanks are due to Professor Hughes, who as treasurer of the fund subscribed by them collectively to defray the general expenses of the Section, has carefully guarded against unnecessary expenditure, and husbanded to the utmost the private money placed in his hands. To Mr. Aylmer, also, every exhibitor is grateful, for by his unvarying kindness and readiness to satisfy every wish expressed to him he has contributed in a high degree to the general harmony and content.

The exhibition now just closed is the most memorable event that has yet taken place in the history of electrical science, and however much electricity may be developed in the future, however splendid may be the electrical displays to come, there can never be another which will excite so world-wide an interest as that which was witnessed at Paris. Several circumstances have combined to render it unique. To begin with, it was the first fruit of its kind. All that has been done with the subtle agent since Thales of Miletus toyed with the excited amber two thousand years ago was represented there. Within the same walls were collected the simple rudiments of great discoveries and their complicated modern outcomes. There the curious visitor might see the first crude pile of Volta, together with the largest and most powerful voltaic batteries now in use; the unpretending compass with which Oersted discovered the deflection of the magnetic needle by a current passing in its neighbourhood and laid the foundation of the electric telegraphs, and exquisite galvanometers which are now so common; the first rough coil of wire from which Michael Faraday drew the tiny magneto-electric spark which has since been coaxed by the genius of inventors into those brilliant electric orbs that filled the palace with an artificial day.

But it is not so much for its relics of the past as for its promise of the future that the Exhibition of 1881 is memorable. It signals an era of new departures. Other exhibitions of a similar class will, doubtless, be held in the course of the next ten or twenty years, and though we know that electrical science is advancing more and more rapidly, still we are of opinion that the chief results for a long period to come will mainly be developments of the applications which have actually been displayed at Paris. We have reached a stage where it is possible in a few minutes to predict the future progress of years.

The beautiful telemeteorograph of Mr. Van Rysselberghe, for example, by which the state of weather at Brussels is telegraphed every ten minutes to Paris, foretells the time when all the principal observatories in Europe, if not in the entire world, will communicate to each other the results of their observations night and day. The telephone which wafts the music of the Opera House to the Palais de l'Industrie bespeaks that happy social state when it will be possible to hear a great orator agitating some burning question of the hour without having to leave one's easy chair and face the miseries of a foggy night and a late suburban train. The telephotograph of Mr. Shelford Bidwell even gives us the hope of being able, sooner or later, to see by telegraph, and behold our distant friends through a wire darkly, in spite of the earth's curvature and the impenetrability of matter. With a telephone in one hand and a

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telephote in the other an absent lover will be able to whisper sweet nothings in the ear of his betrothed, and watch the bewitching expression of her face the while, though leagues of land and sea divide their sympathetic persons. This is a consummation so devoutly to be wished that the inventor who accomplishes it will be well worthy of apotheosis. The electric light, again, is now so far perfected that we can anticipate its use in every home. At the Exhibition we have seen it blazing, in lighthouses, halls, theatres, streets, greenhouses, and private rooms; and it requires no great effort of the imagination to forecast the time when Niagara shall be lighted from its own waters, and the Eddystone by the fury of the waves which beat upon its rocky base. The spectacular use of the electric light, indeed, is illustrated by the illumina- of the granite obelisk in the Place de la Concorde. Every night the great electric lamp on the top of the Exhibition in the Champs Elysée was projected on the monolith, and caused it to stand forth in the darkness like a spectral finger pointing to the stars. The day is not far distant when the ruins of the Colosseum at Rome, or the great temple of Carnac, will be illuminated by the glowing carbons for the wonder and astonishment of tourists. Then if we come to motive power, we have already seen electricity at work driving vehicles by land, water, and air, in the electrical railway of Siemens, the electrical boat and tricycle of Trouvé, and the electrical balloon of Gaston Tissandier. We have seen it ploughing, boring, pumping, lifting, hammering, sawing, as well as driving numerous household contrivances such as fans, punkahs, sewing machines, and coffee-mills. There was even to have been an attempt to cook by it, and had this been done we might have witnessed vegetables, grown by the electric light, and animals slaughtered by the electric spark, both dressed for table by the electric current. The storage of electricity, that great desideratum for its universal application, has also been represented at Paris in the accumulator of M. Faure, which has already called several rival methods into the field. The growing application of electricity to the preservation of health and the arts of surgery has been extensively illustrated, especially by the polyscope of M. Trouvé and the induction balance of Professor Hughes, which was applied by Professor Bell to locate the bullet in the late President Garfield. Anatomical specimens have also been shown electrotyped with copper, silver, and gold, and subtly suggestive of a day when the ancient process of embalming shall give place to a new one, and a man may have his ancestors electro-plated and deposited on shelves within the family mausoleum, together, let us say, with phonographic records of their speech, so that he can recall from time to time the accents of his forefathers.

Without being too fanciful, however, the instances we have given are ample enough to show that a great many new departures have been made of late in the application of electricity to the arts, and that it is difficult to foresee any important use which has not yet been attempted. Doubtless, some unexpected results will be forthcoming, but unless a revolutionary discovery of the essential nature of electricity be made, it is not easy to see what they can be. It is surprising how much has already been done with this mysterious agent without our really knowing what it is, whether matter or motion, or matter in motion. The Exhibition at Paris, in addition to its other novelties, perhaps contained in the experiments of Professor Bjerknes the right clue to a solution of the problem. If his water analogy is more than analogy, then electricity is a wave motion in the mass of some rare ether, in which the vibrating atoms of matter are immersed, just as his little pulsating drums were steeped in the water of his trough. Future research will doubtless elucidate this obscure point, and enable us to know with tolerable certainty the true nature of the terrible but docile geni which is ever serving us more and more faithfully as the fleet carrier of power.

THE CONSERVATION OF ELECTRICITY.*

Two writers claim the discovery of a new principle and give it the above name, but does not the novelty mainly consist in the claim and in the name, for the whole mathematical theory of electricity which we are accustomed to employ is based on it and on Coulomb's law? In the form given by Professor S. P. Thompson it expresses one of the early notions a really thoughtful student receives, but M. Lippmann, after clothing it in a new mathematical dress has used it in this new form in arriving at an important mathematical relationship which certainly possesses considerable value. Now, without wishing in any way to detract from the value of this result, we think it important to distinguish between the result itself and the rather cumbrous machinery by which it has been arrived at, for, as we shall show, everyone when using the ordinary definition of capacity is already, without the employment of cumbrous and unnecessary mathematical expressions, using what has been called this new principle.

M. Lippmann starts with the result obtained experimentally by M. Boltzmann that the charge in a given condenser is proportional to the difference of potentials, and is a linear function of the pressure, and from this he concludes that

$$d\,m = c\,.\,d\,x + h\,.\,d\,p,$$

where m is the quantity of electricity, x the difference of potentials between the coatings of the condenser, p the pressure of the gaseous dielectric separating the plates, c the capacity for pressure p, and h a coefficient.

Now $\int d\,m = 0$ for a closed cycle of operations, and therefore $d\,m$ must be an exact differential, and hence M. Lippmann concludes that

$$\frac{d\,c}{d\,p} = \frac{d\,h}{d\,x},$$

which is a statement of the so-called new principle which he proceeds to use.

But this equation is nothing more than a statement that m is a function of x and p, a fact not only given by M. Boltzmann, but the nature of this function M. Boltzmann also gave. In fact the modern definition of the capacity of a condenser contains M. Lippmann's new principle, and in addition we cannot use this definition mathematically without obtaining the benefit derivable from M. Lippmann's somewhat complicated machinery.

For example, if we merely take M. Boltzmann's result, which, using M. Lippmann's notation, is of the form

$$m = x\,c_0\,(1 + r\,p),$$

it evidently suffices in itself, together with the equation of energy and the expression of volume of gas as a function of x and p, for the complete working of the problem.

Thus our equations are

$$d\,m = c_0\,(1 + r\,p)\,d\,m + x\,r\,d\,p \quad \ldots\ldots\ (1)$$

$$d\,\mathrm{E} = -\,p\,d\,v + x\,d\,m \quad \ldots\ldots\ (2)$$

$$d\,v = \frac{d\,v}{d\,x}\,d\,x + \frac{d\,v}{d\,p}\,d\,p \quad \ldots\ldots\ (3)$$

Substituting in (2) the values of $d\,m$ and $d\,v$ obtained from (1) and (3), and expressing the condition that $d\,\mathrm{E}$ is an exact differential, we have at once, in its complete form, M. Lippmann's interesting result,

$$\frac{d\,v}{d\,x} = -\,c_0\,r\,x.$$

W. E. Ayrton.
October, 1881. John Perry.

* From *La Lumière Electrique*.

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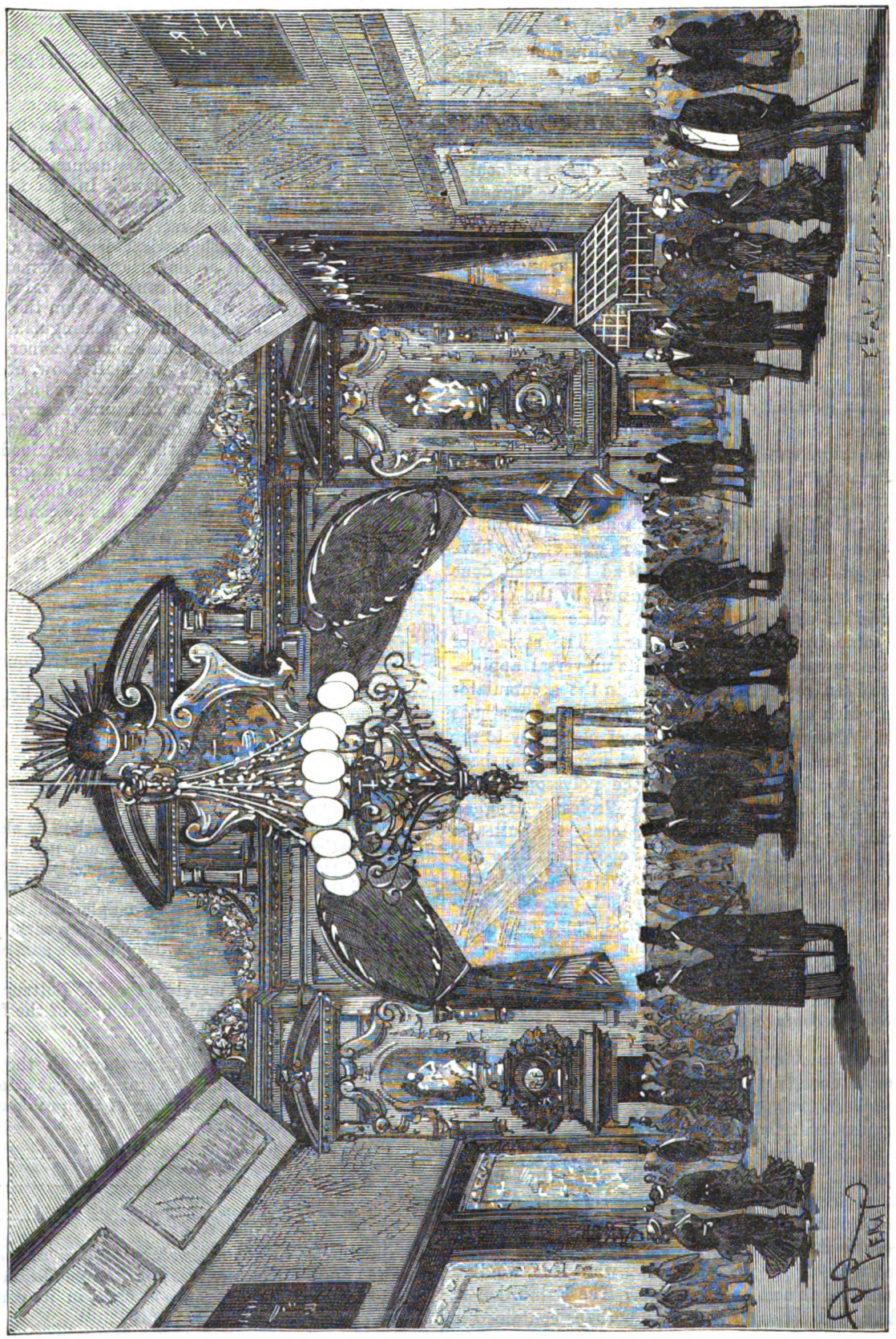
THE ELECTRICAL EXHIBITION AT PARIS.

We reprint in this number the first part of a report specially prepared by Professors Ayrton and Perry for our excellent contemporary the *Engineer*. We hope in our next number to complete the report, and have no doubt all our readers will agree that the enterprise of our contemporary has furnished us with some very valuable statistics. We shall refer to this report again when the whole of it is before our readers. Meanwhile, we may mention an electric lamp which has recently been but little before the notice of the British public. Some years ago, when the semi-incandescent lamp of M. Werdermann was shown in London, it was thought in many quarters to have solved the problem of electric lighting. This idea has, we should imagine, been long ago dispelled, inasmuch as the semi-incandescent lights seem not



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to have recommended themselves to public favour. We have in our various articles on the exhibits at Paris from time to time referred to the semi-incandescent lamps, and, we fear, generally in terms of disparagement; it is but just, then, to give the figures obtained by our friend M. Hospitalier, as mentioned in his articles in *La Nature*. It will be seen that he has followed somewhat closely the method adopted by Professors Ayrton and Perry in their report above mentioned, and restricted his investigation to the arc or incandescent portion itself. For accurate purposes the figures in such tables must be supplemented with exact details of the method of testing employed. Nothing seems more conclusive than that at the present moment we have no trustworthy "unit" for photometric purposes. We have altered M. Hospitalier's photometric measurements in carcels to "candles," taking the carcel as equivalent to 9·5 candles.

Conditions.	Werdermann.	Edison.
Current in ampères (late vebers)	50	·7
F.M.F. between terminals in volts	7	105·0
Luminosity in candles	342	15·2
Candles per horse-power	712·5	152
Number of lamps lighted per horse-power	2·1	10

We have not given all M. Hospitalier's figures, but sufficient to enable his measurements to be placed with those of Professors Ayrton and Perry. It is hardly satisfactory to compare the Edison incandescent light with the Werdermann semi-incandescent. Comparisons of lamps should be made with similar lamps, and we think M. Werdermann's lamp will compare very favourably with other semi-incandescent lamps, such as those of Joel and Regnier.

Our illustration shows the Werdermann lamp as exhibited to light the body of the theatre, or, rather, the room used to represent a theatre, at the Paris Exhibition. The current was supplied by an alternate current Gramme machine, and the effect was generally appreciated.

SUBMARINE CABLES.

The correspondence on this subject, some of which we reproduced in our last issue, was continued in *The Times* of the 24th of November by Mr. T. E. Holland, of Oxford, who wrote as follows:—

"The possibility of giving some legal protection to submarine cables has been carefully considered by the Institut de Droit International. A committee was appointed in 1878 to consider the subject, and the presentation of its report to the meeting at Brussels in 1879 was followed by an interesting discussion (see the 'Annuaire de l'Institut,' 1879-80, pp. 351-394). The conclusions ultimately adopted by the Institut were as follow:—

"1. It would be very useful if the various States would come to an understanding to declare that destruction of or injury to submarine cables in the high seas is an offence under the Law of Nations, and to fix precisely the wrongful character of the acts and the appropriate penalties. With reference to the last-mentioned point, the degree of uniformity attainable must depend on the amount of difference between systems of criminal legislation. The right of arresting offenders, or those presumed to be such, might be given to the public vessels of all nations, under conditions regulated by treaties, but the right to try them should be reserved to the national courts of the vessel arrested.

"2. A submarine telegraphic cable uniting two neutral territories is inviolable. It is desirable that, when telegraphic communication must be interrupted in consequence of war, a belligerent should confine himself to such measures as are absolutely necessary to prevent the cable from being used, and that such measures should be discontinued, or that any damage caused by them should be repaired as soon as the cessation of hostilities may permit."

Another letter, from Mr. R. Kendal, of the West Coast of America Co., said:—"Every one who is interested—and who is not interested?—in the successful working of submarine cables must thank you for your admirable articles and for the contributions of your well-informed correspondents, Sir James Anderson and Mr. Andrews. But if you will kindly allow me, I would suggest that the discussion raised is of far too important a character to be allowed to pass away without producing some palpable and practical effect. The evils are acknowledged, but the remedy is not forthcoming. Sir James Anderson says that 'probably the time is not remote when this now indispensable system of communication between nations may be considered worthy the serious attention of the various Governments.' Now, it occurs to me that though there may be some doubt entertained as to this being the best of all possible worlds, or the present the best of all possible Governments, there can be no doubt as to this being the best of all possible times to agitate the question of submarine cables, and to take some steps towards bringing about a more satisfactory state of local and international legislation. There could be no difficulty in bringing the whole matter before Parliament or in obtaining a committee to investigate it, and make recommendations on which action might be taken by our Government in the first instance, and I would, therefore, respectfully propose that out of the cable companies there should be formed an association which would take the initiative in this and other matters relating thereto, and which would act, not merely in the interest of the many who are concerned in cable property, but for the benefit of all who give a thought to the intelligence which comes every day from every corner of the world. Should this suggestion be thought worthy of being acted upon I should be glad either to undertake the necessary work or to see that the work is done, and this at little or no cost at all."

The commercial element was represented in this correspondence by a letter to *The Times*, of the 1st of December, signed by a "Merchant," the pith of which we reproduce. After stating that matters are going from bad to worse, he says:—"At the same rate of progress in both directions—namely, continued non-repair on the one side and continued breakage on the other—we shall soon arrive by the process of exhaustion within measurable distance of a total paralysis of electrical communication. Meanwhile, it may be just as well to remark that the arrangements of business men are being thrown into confusion, and that loss is being occasioned in certain cases by the non-arrival of telegrams within business hours. Is it too much to ask that some of the highly-paid departments having jurisdiction should make inquiries into the subject and see if some remedy can be applied? What is the Board of Trade about that it makes no move in this matter where trade is greatly concerned?"

The following letter has been sent by Mr. H. G. Erichsen, the representative of the Great Northern Telegraph Company in England, to the Government:—

"Sir: For a number of years the telegraph cables submerged in the North Sea have been exposed to great dangers in consequence of the fisheries carried on in those waters. This danger has increased to such an extent after the general introduction of trawlfishing that it would be most desirable if the matter could be brought under the notice of the International Fisheries Congress now assembled at the Hague, in order that regulations for the protection of the cables may be agreed to by the different Governments. The damage done by the fishing boats is twofold, that caused by anchors and that caused by trawls. The former may be easily averted if the exact position of the cables became more generally known to the fishermen, and this being so there would also be very little difficulty in preventing injury by the trawls, particularly if a proper shape of the same were also adopted, and if it were made compulsory *that the trawls were always kept in proper repair*. The crossing of a cable, or the scraping along a cable of a heavy apparatus like the trawl must in itself be injurious to the same; but the danger is greatly increased when, after the wearing out of the bottom of the trawl, imperfect repairs are effected, as no cable can withstand the action of bolt-heads (not counter-sunk) and sharp projecting edges of clumsily-attached pieces of iron.

"Considering this present state of things it would therefore be very desirable

"1. That fishermen were warned as far as possible to

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avoid anchoring or trawling in places where cables are laid. For this purpose the different Governments might issue charts showing the exact position of the cables, and the different men-of-war which periodically supervise the fishing operations might render valuable assistance in this respect.

"2. That distinct rules were laid down as to the shape of the trawls, and that it were made unlawful to alter the same by subsequent repairs, the due compliance with these rules being secured partially through the above mentioned supervision by the men-of-war, partially through the inspectors of fisheries stationed at the ports of issue in the different countries. Any infringement of these rules ought to be punished with heavy fines.

"3. That rules were laid down for the guidance of the fishermen how to act in cases where they got foul of a cable, the Telegraph Administrations concerned agreeing to compensate the owners of the fishing boats for any anchors or fishing gear which might be lost in their attempts to get clear of the cable without injuring the same on production of satisfactory evidence. Wilful damage ought to be made punishable by heavy fines, or, eventually, imprisonment.

"4. That it were made compulsory for all fishing boats to carry a copy of the above charts, together with a copy of the International Rules, which may be adopted.

"If these or similar rules were adopted by the Governments represented at the Congress, protection, as far as possible, would be given to the owners of telegraph cables and the public, who are more or less dependent upon the efficient working of the same, and at the same time the owners of fishing boats would also be protected. As to their cost, they must know that the crossing of a partly damaged cable means loss or serious injury to their nets. Considering that your department, as owners of many of the North Sea cables, is vastly interested in this matter, I have ventured to bring the same under your notice, and as verbally explained I hope that your department will see the desirability of taking the initiative at the Hague Congress with regard to this question, and to support measures in the same direction which may be proposed by other Governments who are more or less interested in the protection of the telegraph cables in the North Sea.

"Finally, I beg leave to observe that as the sittings of the Congress have already commenced it would be very desirable, if convenient, that instructions might be sent out without delay to the British representative at the Hague Congress."

With reference to the above correspondence we may remark that it is stated that the Government are now prepared to entertain favourably representations about to be made respecting international agreements providing remedies against the present unsatisfactory state of the telegraphic system. With regard to matters nearer home, however, it is said that the Postmaster-General has applied to the Board of Trade to assist the telegraph companies, but has not succeeded in obtaining the co-operation of that department. In the meantime the cables remain unrepaired, and telegraphic intercourse with the Continent is in confusion. According to the latest accounts of the movements of the cable-repairing ships the Submarine Company's "Lady Carmichael" sailed from Lowestoft early in the week for the English Channel. She has not repaired the Reuter cable from Lowestoft to Emden, nor has she attempted the repair of the Dutch cable to North Zandvoort. The Telegraph Construction and Maintenance Company's ship "Kangaroo" is still engaged on the German Union cable. We understand that the fishing boats have so greatly interfered with the repairing operations of the two ships that, although there have been favourable spells of fine weather, nothing effective has been accomplished, and of course in stormy weather both the fishing boats and the cable ships could do next to nothing. It is reported that the "Lady Carmichael" has abandoned for the present her efforts to repair the cable in the North Sea, because two of the cables across the English Channel have been broken during the last gale, and she has consequently been ordered off, leaving the repairs of the North Sea cables to be undertaken at some future time, when the conditions under which she would be able to work may be more favourable.

BOROUGH OF LEAMINGTON.

Electric Lighting.

The following is a copy of the specification for the above work:—

The contract to be executed under these conditions shall include the lighting by electricity of the whole of the Parade, from the south side of Victoria Bridge to its northern end, where it joins the South Parade, as shown upon the plan (see illustration herewith), and coloured yellow thereon. Copies of the same will be supplied to persons tendering. Upon the plan the situations of the various gas lamps at present used are indicated; but parties tendering must assure themselves of the number and situation of the lamps shown thereon. The whole of the Parade must be lighted from sunset to eleven p.m., for a period of twelve months, from ———. The contractor must state in his tender the amount per hour per lamp he will require to continue the lighting after eleven p.m., should the Corporation at any time require the lights to be kept burning later than eleven o'clock. The lamps will require to be lighted and extinguished at the times indicated in the notices, which will be issued on the first day of each month by the borough surveyor, and signed by him. The contractor shall commence the works within three weeks from the date of the notice in writing, issued by the borough engineer to that effect, and complete them ready for lighting within ——— days from that date. All machinery, plant, supports, conducting wire, insulators, lamps, carbons, instruments, and materials of every description, and also all tools, power, labour, and whatsoever may be required to effectively and thoroughly complete the work in the best manner, and to the borough engineer's satisfaction, shall be provided by the contractor. The whole of the materials and plant will be the property of the contractor, who shall, within four weeks after the expiration of the contract, should the Corporation not permanently require the same, remove the whole of such plant and materials at his own expense, and make good and reinstate all lamps, lamp fittings, pipes, paving, &c., at his own expense. The contractor may use the existing lamp columns, or he may erect special posts to carry the lamps, but the wires must be laid under the surface of the roads or footways, as the Corporation may prefer, and he shall state the cost of each of these modes of suspending the lamps. All pavements disturbed will be made good by the Corporation's workmen, at the expense of the contractor, at the following schedule of prices, viz.: York flagging in footways, per yard super, 3s.; wood paving in tramways, per yard super, 9s., stone paving 2s.; macadam in carriageways 6d. These prices do not include filling trenches, which will be done by the contractor to within 3in. of the surface of the York flagging, and 9in. of the surface of macadam or wood paving, and 4in. of the surface of stone paving. All road materials to be replaced as they were, and to be well punned. If the contractor makes use of any gas lamps or pillars he must do it in such manner as to leave the pillars, lamps, and fittings in perfect working order, so that any or all of them can be used in case of the electric light being extinguished either by accident or other cause. Should any gas lamp be unavoidably removed, or its light extinguished, temporary means of lighting with gas must in every such case be forthwith provided by the contractor at his own cost; and the usual gas lights must, under no circumstances, be disturbed in any way unless the sanction in writing of the borough engineer is first obtained. The alterations, removal, fixing, or refixing of any gas lamps or fittings, permanent or temporary, must be done by the Corporation's workmen only, and at the expense of the contractor. The contractor must select the site for the engine and electric machines at the rear of the pump rooms, or wherever else he may consider most convenient. Such site to be approved by the Corporation, and persons tendering must distinctly show upon the plan, or describe in their tender, the exact position of such site. The contractor must make proper provision for protecting the engines, machinery, &c., from the weather, or from injury from any other cause. The contractor must clearly state in his tender how and in what position he will lay the conducting wires, and the number and strength of the same, the description and number of engines and generating machines and lamps, and their respective powers, the depth and position of the conducting wires below the surface of the ground, and the means used to properly protect the wires, and insure their perfect insulation, together with the cost thereof in detail. The position of the electric lamps to be shown upon the plan in a conspicuous manner. The contractor must also state the estimated annual amount of working expenses for labour, fuel, carbons, repairs, and depreciation of plant. He must provide a competent foreman whilst the works of lighting are being constructed, and keep a competent man to manage the machine, and attend to the lamps and lighting under the direction of the borough surveyor, who will have full power to discharge any foreman or workman for misconduct, insubordination,

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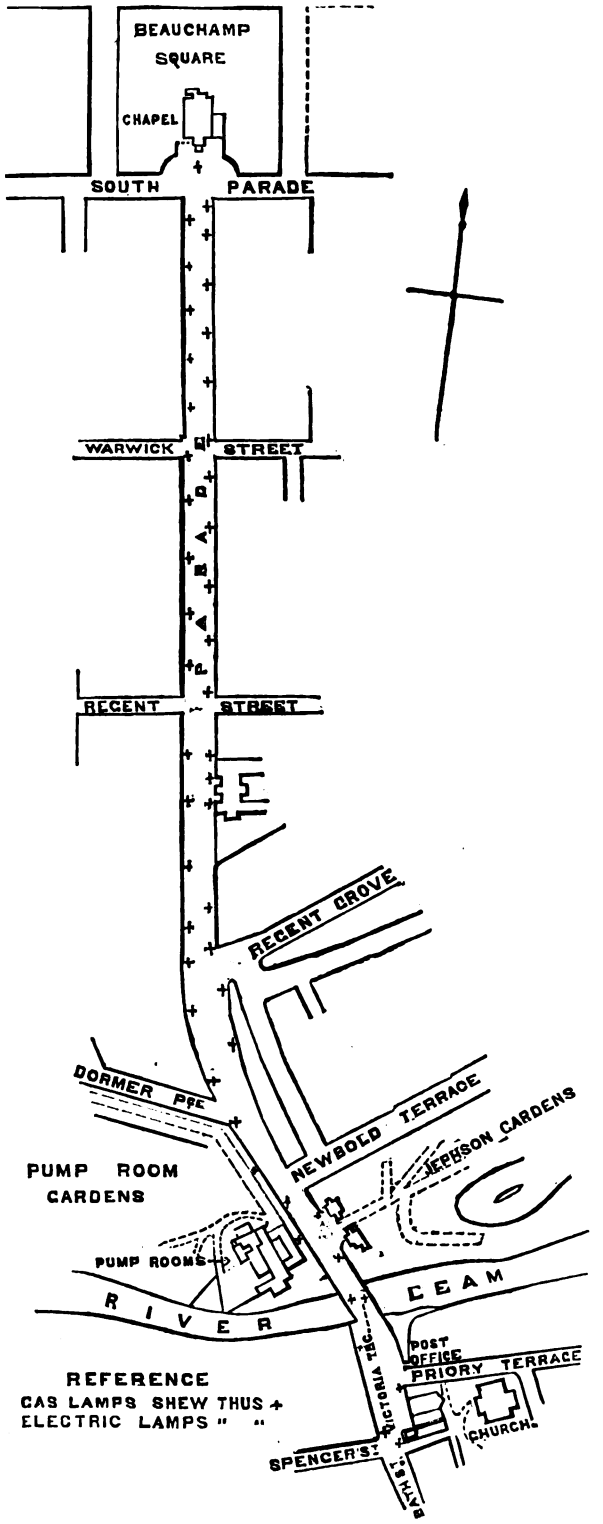
or incompetency, and the contractor shall forthwith provide another foreman or workman of approved character. The contractor will be held responsible for all injury or damage that may be occasioned to persons, or property, or to gas and water mains, telegraph wires, or other things, during the execution or maintenance of these works. Payments for the electric lighting will be made on the second Tuesday in each month upon the certificate of the engineer that the contract has been duly executed. The final payment will not be made until the engineer



certifies that the contractors have complied with all the conditions of the specification and contract. Tenders upon the form appended to the conditions, endorsed "Tender for Electric Lighting," and addressed to the Mayor and Corporation of the Borough of Royal Leamington Spa, must be delivered at the office of the Town Clerk not later than 10 a.m. on the 12th inst. Care must be taken to avoid obstructing the footways or carriage ways, or inconveniencing the public traffic during the progress of the works, and where necessary or required, watchmen and fires shall be provided.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

A rather larger audience than usual assembled on Thursday, the 24th ult., at the Institution of Civil Engineers to hear a report upon the Paris Electrical Exhibition, submitted to the society by Sir C. T. Bright and Professor Hughes, F.R.S. The report was mainly descriptive of the aspect and general arrangements of the exhibits; it in no way attempted to report upon their respective merits. Special notice was, of course, bestowed upon novelties of striking excellence, but on the whole the aim was to give to those who had not had an opportunity of visiting the Exhibition some idea of what was to be seen there and what it looked like. The whole of the sections were gone through, and the leading objects furnished by respective nationalities singled out for description, sometimes in careful detail. For members who have the society's catalogue in their hands it would be superfluous to go over this ground again, and for the general reader the account furnished by Sir C. T. Bright and Professor Hughes, though of much interest to the society they represent, would not be of much assistance or value. The concluding portion of the paper referred in high terms to the great success of the electrical congress which had been organised in connection with the Exhibition, and which had brought together the greatest number of distinguished *savants* that had probably ever met in one place. The results of their deliberations could not yet be made known, but there would doubtless accrue to the world at large many permanent benefits from the decisions arrived at on this memorable occasion. Finally, the authors gave their warmest testimony to the attentive and kindly relations between the representatives of the various exhibits and their French hosts, especially to M. Cochery, to whom the electrical world would ever owe a debt of gratitude for inaugurating this, the first exhibition of its kind, and one that would prove of immense value both to science and to industry. So far as it concerned the British nation we had reason to be gratified with the place we occupied in this public competition with other nations.

The PRESIDENT having invited remarks upon the paper—discussion in the ordinary sense being impossible,

Professor AYRTON invited any of the jurors who were present to inform the meeting what was the method pursued in testing the various exhibits for the purpose of awarding honours.

Mr. J. F. MOULTON, Q.C., F.R.S., being pressed to respond to this invitation, said: It is one of the maxims of English law that a juryman shall not be put into the witness box or be tried for giving his verdict; he enjoys an absolute immunity from its consequences, being required neither to explain nor to justify his opinion. I need not, however, claim this immunity for myself, as it happened that I was not on the jury more immediately connected with matters in which this society and the public take the greatest interest. I may say this much only of the electrical appliances coming under my notice that their excellence and delicacy were truly astounding, so much so that one might say they were waiting for the world to come up to them. The degree of accuracy attained by the makers of instruments used for electrical measurements and testing was almost ludicrous; but at the same time they were thoroughly practical; for although I am afraid to say the number of fractions of an ohm within which these appliances were free from error, they were equally noteworthy for their safety from injury—delicacy did not mean fragility, their serviceableness being as conspicuous as their accuracy. I had also to take note of a section including static electricity; and here it was plain that the world was pretty well where it was thirty years ago—an illustration of the fact that the one enduring stimulus to research is practical utility, and a result which must be grateful to the ears of a society like this, which makes practical utility as well as theoretical speculation its aim.

Mr. GEORGE FORBES, who was pointedly referred to as one of the jurors on electric lighting, congratulated Mr. Moulton on the ingenious manner in which he had avoided giving evidence out of court. For my own part, said Mr. Forbes, I am satisfied that the series of tests which the various machines and lamps were subjected to were of the most searching and conclusive character, such as would satisfy even Professor Ayrton. Owing to an impending change of ministry it is true the awards had to be made before these tests were completed, so that for political reasons over which we had no control the honours cannot be said exactly to be the result of those tests. The exhibitors had to submit to our stern decisions first, and then to our examinations afterwards. Nevertheless the tests were most valuable, and if ever they are published, which I hope they may be, though there is reason to fear they will not, they will prove to be the best and most exhaustive that have ever been made. I may say this much of two methods adopted; one was to employ an engine especially set apart for our use, connecting to it the machine and lamp to be tested in each case, so that the power employed being known the results severally obtained could be compared. The other method was to attach indicators to the exhibitor's own engine; photometric measurements being taken of the lamps in the usual way. All were treated alike, and all [Mr. Forbes was understood to say] were tested by both of these methods, allowance being made for the number of lamps in circuit, &c. I confess that at first I was afraid the measurements would not be taken so satisfactorily; but in the end I was thoroughly content with the results and the means by which they were arrived at. If ever they attain publicity, it will be acknowledged that my statement on this point was fully justified.

Professor ABEL regretted that he could retail nothing to the society from his experience of the Paris Exhibition in reference to the application of electricity to naval and military purposes that had not already come under their notice long ago. None of the Continental nations had made any considerable progress during the past ten years. America, perhaps, was an exception on account of the simplicity and serviceableness of its arrangements. But, on the whole, England had good reason to be proud of its position in this respect. She was conspicuous by her absence at the Exhibition, because it had pleased the authorities at home to keep their exhibits to themselves. That, however, was far from meaning she had nothing to show; and the newspaper correspondents fell into a singular

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error in belauding the appliances of other nations to the disparagement of those of their own country, when, the fact was, we had all the newest, the best, and the most formidable electrical warlike appliances in our own safe keeping. We have absolutely nothing to learn; and if official routine do not stand in the way at any future exhibition, it will be found that other nations have a great deal to learn from us.

Mr. GRAVES: With regard to the apparatus forwarded by the Post Office to the Paris Electrical Exhibition, I have only to say that it adequately represented what it was intended to represent. It was meant only as an historical record of the rise and progress of the electric telegraph in this country. Modern instruments now in actual use were, of course, included, but only to complete the sequence. They were not joined up, and were not at work. Our instructions were not to enter into competition with our foreign neighbours in any shape or way, and we carried those instructions out. Self-abnegation was the attitude we were required to assume, and that we played the character tolerably well is pretty evident from the tremendous blowing up we got in various newspapers for not doing more than we did do.

Major FLOOD PAGE offered some remarks upon the forthcoming Electrical Exhibition to be held at the Crystal Palace, and expressed a hope that the home Government, both in its civil and military character, would allow itself to be adequately represented there.

After some remarks from Mr. STROH, relating to the kind of steel best suited for magnetic purposes, the meeting closed with a vote of thanks to the authors of the report.

PHYSICAL SOCIETY.

Nov. 26.—Professor W. G. Adams in the chair.

Mr. C. VERNON BOYS read a paper on "Integrating Apparatus." After referring to his original "cart" machine for integrating, described at a former meeting of the society, he showed how he had been led to construct the new machine exhibited, in which a cylinder is caused to reciprocate longitudinally in contact with a disc and give the integral by rotation. Integrators were of three kinds, first, radius machines, second, cosme machines, third, tangent machines. Sliding friction and inertia render the first two kinds unsuitable where there are delicate forces or rapid variations in the function to be integrated. Tangent machines depend on pure rolling, and the inertia and friction is inappreciable. They are, therefore, more practical than the other sort, and it is to this class that Mr. Boys' machines belong. The author then described a theoretical tangent integrator, depending on the mutual rolling of two smoke rings, and showed how the steering of a bicycle or wheelbarrow could be applied to integrate directly with a cylinder either the quotient or product of two functions. If the tangent wheel is turned through a right angle at starting, the machine will integrate a reciprocal, or it can be made to integrate functions by an inverse process. If, instead of a cylinder, some other surface of revolution is employed as an integrating surface, then special integrations can be effected. He showed a polar planimeter in which the integrating surface is a sphere.

A special use of these integrators is for finding the total work done by a fluid pressure reciprocating engine. The difference of pressure on the two sides of the piston determines the tangent of the inclination of the tangent wheel which runs on the integrating cylinder, while the motion of the latter is made to keep time with that of the piston. In this case the number of revolutions of the cylinder measures the total amount of work done by the engine. The disc cylinder integrator may also be applied to find the total amount of work transmitted by shafting or belting from one part of a factory to another.

An electric current meter may be made by giving inclination to the disc, which is for this purpose made exceedingly small and delicate by means of a heavy magnetic needle deflected by the current. This, like Edison's, is a direction meter, but a meter in which no regard is paid to the direction of the current can be made by help of an iron armature of such a shape that the force with which it is attracted to fill the space between the poles of an electro-magnet is inversely as its displacement. Then by resisting this motion by a spring or a pendulum, the movement is proportional to the current, and a tangent wheel, actuated by this movement, causes the reciprocating cylinder on which it runs to integrate the current strength. Mr. Boys exhibited two such electric energy meters—that is, machines which integrate the product of the current strength by the difference of potential between two points with respect to time. In these the main current is made to pass through a pan of concentric solenoids, and in the annular space between these is hung a solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "induction traps" of iron the magnetic force is confined to a small portion of the suspended solenoid, and by this means the force is independent of the position. The solenoid is hung to one end of a beam, and its motion is resisted by a pendulum weight by which the energy meters may be regulated like clocks to give standard measure. The beam carries the tangent wheels, and the rotation of the cylinder gives the energy expended in foot pounds or other measure. The use of an equal number of turns in opposite directions on the movable solenoid causes the instrument to be uninfluenced by external magnetic forces. Mr. Boys showed on the screen an image of an electric arc, and by its side was a spot of light whose position indicated the energy, and showed every flicker of the light and fluctuation of current in the arc. He showed on the screen that if the poles are brought too near the energy expended is less, though the current is stronger, and that if the poles are too far apart, though the electromotive force is greater, the energy is less; so that the apparatus may be made to find the distance at which the greatest energy, and so the greatest heat and light, may be produced.

At the conclusion of the paper Professor W. G. ADAMS and Professor G. C. FOSTER could not refrain from expressing their high admiration of the ingenious and able manner in which Mr. Boys had developed the subject.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Nov. 30.		Business Done Week Ending Nov. 30. Highest.		Lowest.	
Anglo-American	52¼,	53	.....	54	.....	52¼
Do. Preferred	81,	82	.....	82¼	.....	81¼
Do. Deferred	23,	23½	.....	23½	.....	23½
Brazil Submarine	10¾,	11¼	.....	11¼	.....	11
Cuba	9½,	10	.....	—	.....	—
Do. Preference	16,	17	.....	—	.....	—
Direct Spanish	4¾,	5¼	.....	5¼	.....	5¼
Do. Preference	14,	16	.....	14¼	.....	14¼
Direct United States Cable	10¾,	11¼	.....	11¼	.....	10¾
Eastern Telegraph	10,	10¼	.....	10¼	.....	10¼
Do. 6 per Cent. Preference	12¾,	13	.....	12¾	.....	12¾
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	10¾,	11	.....	11	.....	10¾
German Union	10¼,	10¾	.....	10¾	.....	10¾
Globe Telegraph and Trust Company.	6¼,	6¾	.....	6 11-16	.....	6 9-16
Do. Preference	12¾,	12¾	.....	12¾	.....	12¾
Great Northern	12¼,	12¾	.....	—	.....	—
Indo-European	27½,	28½	.....	28½	.....	27½
Mediterranean Extension	2¼,	3	.....	2¼	.....	2¼
Do. Preference	9½,	10	.....	9¼	.....	9¼
Reuter's	12,	12½	.....	—	.....	—
Submarine	290,	300	.....	296	.....	296
West India and Panama	1⅝,	1¾	.....	1¾	.....	1¾
Do. 1st Preference	7¼,	8	.....	7 9-16	.....	7 9-16
Western Brazilian	7¼,	7¼	.....	7 5-16	.....	7 3-16
West. Union 7 per Cent. 1st Mortgage	123,	128	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	104,	107	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	.....	1¼	.....	1¼
Oriental	¼,	¼	.....	¼	.....	¼
United Telephone	9,	9¼	.....	—	.....	—

ELECTRIC LIGHT.

Electric Light and Power	1¼,	1¾	.....	1 5-16	.....	1¼
Anglo-American Brush	8,	8½	.....	8	.....	7 7-16

BOROUGH OF ROYAL LEAMINGTON SPA.
ELECTRIC LIGHTING.

The Corporation of the Borough of Leamington invite TENDERS for LIGHTING the PARADE with ELECTRIC LIGHTS.

The specification can be seen, and all particulars obtained, upon application to the Borough Engineer, E. M. RICHARDS, Esq., C.E., at the Town Hall, on and after WEDNESDAY, the 23rd Nov.

Sealed tenders, addressed to the Mayor and Corporation, and endorsed "Tender for Electric Lighting," to be delivered at my Office not later than Ten a.m., on MONDAY, the 12th day of December next.

The Corporation do not bind themselves to accept the lowest or any Tender.

H. CONSETT PASSMAN, Town Clerk.

Town Hall, Leamington, November 16th, 1881.

ELECTRIC LIGHT.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

Capital £800,000; First Issue £400,000.

VICTORIA WORKS, BELVEDERE ROAD, & VINE STREET, LAMBETH.

The Corporation is prepared to give estimates and to book orders for the SUPPLY of MACHINERY and LAMPS, upon the Brush System, for lighting up Factories, Warehouses, Railway Stations, Docks, Streets, &c.

The Corporation are willing to receive applications for licences or concessions for defined districts, counties, or towns in the United Kingdom.

By the Brush system any number of lights, from 1 to 40, each of 2,000 candle power, or any number from 1 to 12, each of 6,000 candle power, or a single light of 50,000 or more candle power, can be produced from one dynamo machine. The connecting wires may be extended over circuits of many miles, and it is claimed that economy, constancy, and simplicity are secured at a less cost than by any other system.

The Corporation is also prepared to supply for domestic lighting, incandescent lamps of 10-candle power and upwards, manufactured with the newest improvements, under the "Lane-Fox" system. These lights are suitable for private houses, business offices, clubs, hotels, &c.

Concessions for the colonies and for foreign countries of the valuable patent rights under both of these systems, including methods of manufacture, regulation, and distribution, can be negotiated with the Corporation.

All inquiries to be addressed to the Secretary, at the offices, Belvedere-road, Lambeth, S.E.

J. A. BERLY'S ELECTRICAL DIRECTORY and ADVERTISER of ENGLAND, 1882.

INTENDING ADVERTISERS in the 1882 EDITION (first issue), should at once apply for particulars, terms, &c., to J. A. BERLY, 16, New Bridge-street, London, E.C.

For Press opinions vide "Times," 18th; "Iron," 18th; "Engineering," 18th; "Electrician," 19th Nov., 1881; "Telegraphic Journal," 1st Dec., 1881, &c.

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CRYSTAL PALACE.

INTERNATIONAL ELECTRIC EXHIBITION.

LIST OF CLASSES.

1. STATIC ELECTRICITY.
2. BATTERIES and ALLIED APPARATUS.
3. MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.
4. CABLES, WIRES, LIGHTNING CONDUCTORS.
5. APPARATUS FOR MEASURING ELECTRICITY.
6. TELEGRAPHS AND SIGNALS.
7. TELEPHONES, MICROPHONES, PHOTOPHONES.
8. ELECTRIC LIGHTING.
9. ELECTRIC MOTOR POWER.
10. ELECTRO-MEDICAL.
11. ELECTRO-CHEMISTRY.
12. MAGNETS, COMPASSES, HOROLOGY, etc.
13. MISCELLANEOUS.
14. GENERATORS, GAS, STEAM, WATER ENGINES, etc., APPLICABLE TO ELECTRIC INDUSTRIES.

SPACE HAS ALREADY BEEN ALLOTTED TO THE FOLLOWING EXHIBITORS:—

CLASS VIII.—ELECTRIC LIGHTING.

Anglo-American Brush Light Corporation.
British Electric Light Company.
Cance, A.
Clark (Latimer), Muirhead and Co.
Compagnie Générale d'Electricité.
Crompton, R. E.
Edison, T. A.
Electric Light and Power Generator Company.
Electric Light Engineering Company.
Electric Lighting Supply Company.
Electric Light Carbon Company.
Elmore W.
Gerard, A.
Graham, D. H.
Gravier and Co.
Hammond and Co.
Hawkes (G.) and Co.
Henley, W. T.
Macdonald, J. Kay Athole.
Mignon et Rouart.
Rowatt and Fyfe.
Scientific Toy Company.
Siemens Brothers and Co.
Siemens Frères.
Sonzée, M. Leon.
Swan Electric Light Company (Limited).
Strode and Co.
Thomas, Evan.
Varley (S. A.) and Co.
Werdermann, R.
White House Mills Company.

Announcements of other allotments will be made from time to time.

THE DIRECT UNITED STATES CABLE COMPANY, LIMITED.

Direct Cable Route for Telegrams

TO

NEW YORK, BOSTON, SAN FRANCISCO, PHILADELPHIA, CHICAGO, NEW ORLEANS, MONTREAL, TORONTO, QUEBEC,

And all other Telegraph Stations in the United States of America, Canada, West Indies, &c.

REDUCTION OF TARIFF.

RATE TO NEW YORK & CANADA - - - - 1/- PER WORD.

HEAD STATIONS (ALWAYS OPEN).

LONDON ..... 34, THROGMORTON STREET, E.C.
LIVERPOOL... D6, EXCHANGE BUILDINGS.
BOSTON ..... 122, STATE STREET.
NEW YORK... 16, BROAD STREET.

BRANCH STATIONS IN LONDON.

SOUTH SEA HOUSE (adjoining the "Baltic"), THREADNEEDLE STREET, E.C.
EAST INDIA AVENUE, LEADENHALL STREET, E.C.
THE COMMERCIAL SALE ROOMS, MINCING LANE, E.C.
52, OLD BROAD STREET, E.C.

BRANCH STATION IN NEW YORK: 444, BROOME STREET.

To save time, the Public in **LONDON, LIVERPOOL, BOSTON** and **NEW YORK**, are recommended to hand in their Telegrams at the Company's Stations as above, where receipts are given for the amounts charged.

Telegrams handed in at Postal Telegraph Offices, must be marked "Viâ DIRECT CABLE." This instruction is signalled free of charge.

The Name of the Place from which Messages originate is transmitted Free of Charge.

The Direct transmission of Messages between London, Liverpool, Boston, and New York, and their delivery and receipt in these Cities, is entirely under the independent control of this Company.

General Offices, 52, Old Broad Street, London, E.C. J. W. FULLER, *Secretary and Traffic Manager.*

Just published, Crown 8vo., cloth, 12s. 6d.

A HANDBOOK of ELECTRICAL TESTING. By H. R. KEMPE, Member of the Society of Telegraph Engineers, Assoc. Mem. Inst. C.E. Second Edition, Revised and Enlarged.
London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street.

HARBOROW & CO.,
ELECTRIC LIGHT ENGINEERS
AND
TELEGRAPH INSTRUMENT MANUFACTURERS,
4, CIRCUS STREET, LONDON, W.

DUNCAN WALLET & CO.,
BONDED STORE AND PROVISION MERCHANTS,
15, BILLITER STREET, LONDON.
Special Arrangements made for Supply of Goods to Telegraph Stations.

D. W. & Co. have supplied Provisions to the Stations of the Eastern and South African Telegraph Companies, and are prepared to execute orders on specially favourable terms at shortest notice.

INSULATED COPPER WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handled Cord, Silk Cord for Electric Bells, &c.—J. and W. RICKARD, Insulated Wire Manufacturers, Ashbourne-road Mills, Derby

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ADDRESSES.

M. THEILER & SONS, Manufacturing Electricians, 86, CANONBURY ROAD, LONDON, N. Factory: 1, Alwyne-lane, N.
Specialities—Morse Instruments, Type Printers, Cable Relays and Keys, DUPLEX, Quadruplex, & Translating Apparatus, P.O. Pattern.
THEILER'S PATENT TELEPHONE TRANSMITTER, with Sensitive Bell, &c. Complete, price £3 10s.

TAYLOR and Co., Mica Merchants, 90, HATTON GARDEN, LONDON.

W. T. GLOVER and Co., Insulated Wire Manu-facturers, 25, BOOTH-STREET, MANCHESTER. Works: 4 and 5, BRIDGEWATER-STREET, BROUGHTON-ROAD, SALFORD.
Specialities—Specially covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron Wire for Aerial Lines. Fancy covered Copper Wire (Paraffined) for Telephonic and Bell purposes. Cotton covered G.P. Wire for Bell Work. Special Makes of Electric Light Leads for the Brush, Gramme, &c., systems.
All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

RANSOMES, HEAD, & JEFFERIES, Orwell Works, IPSWICH. London Office: No. 9, GRACECHURCH-STREET, E.C.
Specialities—Portable, Vertical, and Stationary Engines, fitted with patent governors, as used in the electric lighting on the Thames Embankment, London, &c.

BRITISH ELECTRIC LIGHT COMPANY (Limited), HEDDON-STREET, REGENT-STREET, LONDON, W.
Gold Medal at the Paris Electrical Exhibition, 1881.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

EDWARD PATERSON, Electrical and Telegraph Engineer, 76, LITTLE BRITAIN, LONDON, E.C., and European Telegraph Works, POWNALL-ROAD, DALSTON.
Telephones and Transmitters, and all Fittings for Central Exchange Systems and Private Lines. Ayrton and Perry's Instruments for Electric Light Measurements. Electric Lighting Apparatus, Cables, &c. House and Mine Signals.

PHILLIPS BROS., Electricians and Electrical Wire Manufacturers, MACINTOSH-LANE, HOMERTON, LONDON.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

JULIUS SAX, Electrician, 108, GREAT RUSSELL STREET, BLOOMSBURY. Manufactory: Morwell Street, Bedford-square, London, W.C.

BARRAUD and LUNDS, 41, Cornhill, London, E.C.
Inventors, Patentees, and Manufacturers of Synchronised Clocks, Time Balls, Flashing Signals, and all the Apparatus connected with the Determination, Distribution, and Control of Time Signals.

NEWTON'S PATENT LAW and PRACTICE, Price 2s. 6d.
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TRUBNER and Co., Ludgate-hill, and may be obtained at the Office for Patents, 66, Chancery-lane, W.C.

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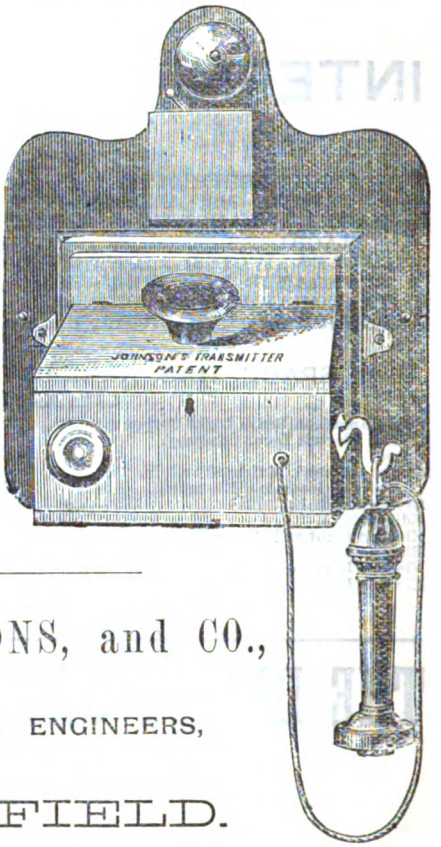

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The best combination for Exchange and Private Lines.

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VULCANITE.

HARBURG INDIA-RUBBER COMB COMPANY.

LONDON WAREHOUSE: F. WINTER.

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BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

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FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane

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Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

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As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public. It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

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Manufacturers of Iron and Steel Ropes for Colliery and Railway purposes. Rigging Ropes, Guide Ropes, &c.

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SLIP

THE "DACIA."—The cable ship "Dacia" passed Madeira on the 1st instant, "all well."

ERRATUM.—In our notice of birth on page 29 of this volume, the name should read Lawton, not Lawson.

TUNIS.—It is reported that the telegraph line from Susa to Tunis will be re-established at the end of the month.

BRITISH ELECTRIC LIGHT COMPANY.—Professor George Forbes, F.R.S.E., has been appointed manager of this company.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended November 18 were £3,907.

SOCIETY OF ARTS.—Mr. Preece is to read his paper on "Electric Lighting at the Paris Exhibition" at next Wednesday's meeting of this society.

ELECTRIC LIGHT FOR SHEERNESS.—The Local Board of Sheerness have requested their clerk to obtain information as to the cost of electric lighting.

CABLE LAYING AT QUEBEC.—Recent news from Quebec said that the steamer "Druid" was laying a new cable across the mouth of the Saguenay River.

ELECTRIC MOTORS FOR NEW YORK RAILWAYS.—It is stated that experiments may soon be made with Siemens's electric motors on the elevated railways of New York.

DIRECT SPANISH TELEGRAPH COMPANY. — The traffic receipts of this company for the month of November, 1881, amounted to £1,810, against £1,465 in the corresponding period of last year.

AN ELECTRIC RAILWAY AT EISENACH.—It is stated that an electric railway is to be constructed at Eisenach, from the Station to the Castle of the Wartburg, if the Royal permission can be obtained.

ELECTRIC LIGHT FOR SALISBURY.—The Town Council having acquired the town mill, with the object of preventing floods, are thinking of turning it to account to produce electricity for lighting purposes.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of November, 1881, amounted to £49,829, against £45,669 in the corresponding period of 1880, being an increase of £4,160.

ELECTRIC LIGHT AT CAPE TOWN.—It is reported that the whole of Cape Town is to be lighted by means of electricity, and that the Town Council have given notice to terminate their contract with the gas company.

INDIAN TELEGRAPH DEPARTMENT.—According to the *Colonies and India* a new scheme for the reorganisation of the inferior and upper subordinate grades of the Government Telegraph Department has been promulgated.

ROYAL SOCIETY.—The following papers were read at a meeting of this society on Thursday last:—"On Seismic Experiments," by J. Milne and T. Gray; and "On the Electrolytic Diffusion of Liquids," by Dr. G. Gore, F.R.S.

ELECTRIC LIGHT FOR THE LIVERPOOL MARKETS.—At a recent meeting of the Liverpool Markets Committee it was resolved that the surveyor should report as to the practicability and cost of lighting the markets by electricity.

DISTRIBUTION OF ENERGY BY ELECTRICITY.—Our excellent and enterprising contemporary, *La Lumière Electrique*, devotes the whole of its issue for the 3rd inst. to an exhaustive article, by M. Marcel Deprez, on the above subject.

TELEGRAPHIC COMMUNICATION WITH LIGHTSHIPS.—The Telegraphic Construction and Maintenance Company have obtained an order from the Trinity House to construct and lay an experimental cable between the Sunk Lightship and Harwich.

DIVIDEND.—The Directors of the Brazilian Submarine Telegraph Company have declared an interim dividend of 3s. per share, or 6 per cent. per annum, free of income-tax, for the quarter ended 30th September last, and payable on the 24th inst.

CABLE REPAIRED.—The Great Northern Telegraph Company have received information of the repair of their Wladiwostock-Nagasaki cable; communication by this company's route with all places in China, Japan, and Manila is thus re-established.

ELECTRIC LIGHT AND SHIPBUILDING.—It is announced that Messrs. Wm. Gray and Co., owners of the largest iron shipyard at Hartlepool, have decided to adopt the electric light, so as to enable them to carry on their operations by night as well as by day.

ELECTRIC CLOCKS IN CONSTANTINOPLE.—According to *La Lumière Electrique*, a system of synchronising clocks by electricity has been introduced into the Stamboul quarter of Constantinople. Perhaps if the Turks begin by keeping time they may end by keeping faith.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this company for the half month ended the 30th November are £2,227, as compared with £1,171 in the corresponding period of 1880. The September receipts, estimated at £2,964, realised £3,308.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company in November, 1881, amounted to £17,120. In the period from 1st January to 30th November they were £222,000, as against £219,922 in the corresponding months of 1880, and £190,887 in 1879.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of the Eastern Extension Australasia and China Telegraph Company for the month of November, 1881, amounted to £32,557, and to £29,724 for the corresponding period of 1880. Increase £2,833.

CROSSING THE CHANNEL IN AN ELECTRIC BOAT.—*L'Electricité* says that the boat in which it is proposed to cross the Channel between Boulogne and Folkestone, as we noticed in a recent issue, is almost ready, and is only awaiting its electric motors, which should be ready for fixing by the 15th instant.

THE TELEGRAPH IN CHINA.—Intelligence has been received of the completion of the telegraph line between Tientsin and Shanghai. This line has been erected by the Great Northern Telegraph Company. The line is about 1,000 miles long, and we believe there are to be some nine or ten stations.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—This Company notify that they have opened a station at Maldonado, in Uruguay, for which place messages can be received at any postal telegraph office in the kingdom, or at any of the offices of the Eastern Telegraph Company, the charges being 15s. 8d. per word.

ELECTRIC LIGHT FOR STOCKTON.—The Urban Sanitary Authorities of Stockton are also owners of the gasworks there, and are alarmed at the strides the electric light is making. They have desired their gas committee to consider whether they shall now make arrangements for supplying electric light as well as gas.

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CLEVELAND INSTITUTION OF CIVIL ENGINEERS.—Amongst the papers down for reading at the above institution during the approaching session, we notice one by Mr. Richard Harrison of Newcastle, on "Improvements in Electric Lighting." The meetings are held in the hall of the Literary and Philosophical Society, Middlesbro.'

ELECTRIC LIGHT AT BISHOP AUCKLAND (DURHAM).—Messrs. Duff and Rowntree, drapers, &c., introduced the electric light into Bishop Auckland a few nights ago, the outside of their business premises being lit up by a powerful arc light. Arrangements are in progress for lighting the interior of the shop by Swan's incandescent lights.

DIRECT SPANISH CABLE.—With reference to our note of last week we are informed that this cable has broken in 100 fathoms of water, close to Bilbao. The ss. "Oersted," chartered by the India Rubber and Telegraph Works Company, was to have started to repair the cable on Tuesday last. Mr. H. Benest goes out as engineer in charge of the work.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of November was 2,334, estimated to produce £2,600, against 1,906 messages, producing £1,960 in the corresponding month of last year. The traffic receipts for the month of September, estimated at £2,000, realised £2,030.

CABLE REPAIRING.—The steam ship "Morna," which has just been fitted up for the Postal Telegraph Department by the India Rubber, Gutta Percha, and Telegraph Works Co., under the directions of Mr. D. Lumsden (the marine superintendent), left the river last Friday for the repair of some of the Government cables which have suffered from the late succession of gales.

ANOTHER LOCAL CABLE BROKEN.—Several days ago the cable between Ardbeg Point, Rothesay, and Ardyne Point, on the Cowal side, in Scotland, was broken. Messages have therefore to be sent by steamer by a roundabout route, and then wired on to their destination. The town council of Rothesay have resolved to memorialise the Postmaster-General on the subject.

THE ELECTRIC LIGHT AT BARNSLEY.—The lighting here is being conducted somewhat under difficulties. It appears that the other night some one stopped up the engine chimney, thus interfering with the proper working of the machinery. Messrs. Hammond and Co. have offered a reward for the apprehension of the offender. Electric lighting cannot be successful under such conditions.

ELECTRIC LIGHT AT DUDLEY.—Last week we announced that the electric light was to be introduced into Dudley. We have now some further particulars to hand. It appears that the offer of Messrs. Hammond and Co. to light the Market-place from St. Thomas's Church to St. Edmund's Church with six Brush lights at a cost of £180 for twelve months has been accepted by the Town Council. These lights are to replace fifty-five gas lamps.

ANOTHER ELECTRIC TRAMWAY FOR PARIS.—It is reported that a tram car worked by electricity is to be run in the Rue de Rennes. The feature of the experiment will be that the current will be conducted along the inner face of the rails, and not by means of a wire supported on poles as in the present Siemens tramway. This means of conveying the current, or something very similar, has been tried before by Messrs. Siemens at Berlin.

ELECTRIC LIGHT IN TRAINS.—A successful trial trip with the new Pullman car train was made on the London, Brighton, and South Coast Railway last week. The cars were lighted with twenty-nine Edison incandescent lamps, supplied with electricity from some of Faure's accumulators. Everything worked well, and the trial was a complete success. The cars are also fitted with electric bells. The train was to have begun running regularly on Monday last.

LARGE DYNAMO MACHINE.—*La Révue Industrielle*, in a recent issue, describes and illustrates a large Gramme machine which has been constructed especially for electro-chemical work, such as nickel plating. It is calculated that with 500 revolutions per minute this machine will give an E.M.F. of eight volts if connected up for tension, and four volts if connected for quantity. The total weight of copper used in the machine is 735 kilogrammes, and the whole machine weighs 2,500 kilogrammes.

ELECTRIC RAILWAYS IN AMERICA.—Edison evidently means business in pushing his system of electrical railroads, if the reports current are to be credited. It is stated that a contract has been entered into by him with the Northern Pacific Railroad for the construction of fifty miles of railroad in Minnesota. The section is to be finished during the course of the next year, and only if the tests to be made to prove its efficiency are satisfactory is full payment to be made.—*Engineering and Mining Journal*, New York.

CARPENTER'S BOAT-LOWERING APPARATUS.—We understand this apparatus has been attached to the boats of the Eastern Telegraph Company's ss. "Chiltern" and "John Pender." Captain Goodsall, of the former vessel, writes:—"The boat-lowering and disengaging gear answers very well; we have used it over one hundred times without any hitch." It is of great importance that the boat gear of cable ships should be simple and efficient, and from the foregoing statement it seems that Carpenter's system answers to these requirements.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company have declared an interim dividend of sixpence per share, free of income tax, payable on the 31st December. It is announced that the company have taken large premises in Farringdon-road, and that they are being fitted up on a large scale. The company are about bringing out a new combination telephone, which it is expected will prove more serviceable and efficient than any instrument yet produced. The share register will be closed from the 21st to the 31st inst., both inclusive.

GAS COMPANIES AND THE ELECTRIC LIGHT.—In a letter to our contemporary the *Journal of Gas Lighting*, Mr. W. Livesey gives a list of the Corporations and Gas companies who have given notice of intention to apply for powers next session to supply the electric light as well as gas. They are as follow:—*Corporations:* England—Accrington, Blackburn, Bolton, Chadderton, Hull, Liverpool, Macclesfield, Manchester, Newcastle, Padiham and Hapton. Scotland—Aberdeen, Dundee, Glasgow, Greenock. *Gas Companies*—Bromsgrove, Exmouth, Lincoln, Milford Haven, Northwich, Rothwell, Rugby, and Ventnor.

CRYSTAL PALACE INTERNATIONAL ELECTRIC EXHIBITION.—Since our last list of exhibitors was published the following allotments have been made:—Mr. W. Groves (for Professor Hughes's induction balance, and other apparatus) the Direct United States Cable Company, John Davis and Son, the Phosphor Bronze Company, the London Electric Light Agency, Walter T. Glover and Company, Mr. Sennett (for Paccinotti's original machine), the Anglo-American Telegraph Company, the Turner Gas Engine Company, M. Bardillon, the Gutta Percha Company, M. Paget, Messrs. Calder and Barrett, Mr. Jacomb (London and South Western Railway), Mr. Clinton M. Ball, and several others.

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THE CABLES BETWEEN DOVER AND FRANCE.—It has been ascertained that both cables belonging to the Submarine Telegraph Company between Dover and Cape Grisnez, near Boulogne, and the South Foreland and Sandgatte, near Calais, are broken. Tests recently made show that the fault in the Boulogne cable is situate about three miles and a quarter from the shore at Cape Grisnez, and in the Calais cable about five or six miles off Sandgatte. The cable ship "Lady Carmichael" was out the latter end of last week searching for the broken ends of the cables, but without success owing to the heavy sea on. Several grapnels were broken during the operations, which seemed likely to be indefinitely suspended unless finer weather set in.

EXPERIMENTS WITH DYNAMO MACHINES.—It is stated that an exhaustive series of experiments are being carried out at Portsmouth with the object of determining the best dynamo machine for the working of "search" lights on board ship. Three machines are under trial, the D Gramme, which supplies a single light of 20,000-candle power; the C T Gramme machine, which provides two lights of 10,000-candle power each, but which can be coupled up so as to give a single powerful light equal to 22,000 candles; and a new Brush machine, which supplies a still stronger search light, but with additional engine-power. Each machine is driven for four hours, and careful observations are made for the purpose of ascertaining the respective horse-power required (diagrams being taken every quarter of an hour), the amount of resistance, the consumption of fuel, and the comparative illumination of the lights, which is measured by means of a photometer.

GAS ENGINES.—Professor W. E. Ayrton delivered a lecture on this subject at the late Paris Exhibition, which has been translated, and is published by Messrs. W. Dawson and Sons, 121, Cannon-street. This lecture contains much interesting information. It is startling to read that with a condensing steam engine it is not possible to obtain more than one-fifth efficiency even under ideal circumstances, yet this is shown to hold by an investigation of Carnot's formula $\frac{S-T}{S+273}$. The efficiency of hot air engines is discussed, but, as might be supposed from the title of the lecture, gas engines are dealt with at greater length, and details are given of the Dowson process for obtaining gas. The table at the end, comparing the economy of a portable steam engine, an Otto gas engine worked with coal gas, and a similar engine worked with Dowson gas, is so astonishing that, if accurate, we are inclined to think gas has more to fear from the Dowson process than from the electric light.

THE TELEGRAPH IN BOMBAY.—The local telegraphic system in Bombay has of late received a marvellous development. The opening of district offices and the introduction of a low tariff have resulted in such an increase of business that Mr. Walton, the Superintendent, has found it necessary to make new arrangements to supplement the existing appliances and enable the department to keep pace with the growing requirements of the public. A number of pneumatic despatch tubes will shortly be laid down between the central office and seven different localities, including Colaba, the Docks, Mazagon, Marwaree, Bazaar, &c., which will serve for the rapid transmission of the messages as received to the central office, whence they will be telegraphed direct to their destination. The answers and other messages received at the central office will in like manner be sent out through the tubes to the local centres, whence they will be transmitted to their addresses, without delay, by the office peons. By this arrangement a great saving of time and trouble will be effected, and the necessity for increasing beyond all bounds the number of telegraph wires traversing the streets will be obviated. It is a wholesome sign of commercial and social progress that Bombay has taken so kindly to the local telegraph system.—*Homeward Mail.*

LEGAL.—ERICHSEN v. LAST.—This case, which was an appeal by Mr. Erichsen, representing the Great Northern Telegraph Company, from an order made by Justices Lindley, Williams, and Mathew on a case stated by the Income Tax Commissioners for the city of London, came on for hearing before their lordships sitting on the Revenue side of the Queen's Bench Division this week. The question at issue was whether the Great Northern Telegraph Company had been properly assessed by the Commissioners at a sum of £40,000 for the financial year ending April, 1877, in respect of the profits of their business as carried on in the United Kingdom, with which the company's chief office at Copenhagen is connected by three cables—one at Peterhead, in Scotland, and two others at Newbiggin, near Newcastle. For the company it was contended that as no profits were made by them on the transmission of messages by their land lines in the United Kingdom, they were not liable to be assessed under Schedule D of the Income Tax, and in the alternative that, if liable to be assessed at all, it could only be in respect to the profits on the transmission of messages over their three cable lines. On the other hand, it was contended by the Surveyor of Taxes that, as the company had an agency in this country which received payment direct from the senders of messages at the rate of £70,000, they were liable to the tax on the total profits earned in this country from the transmission of messages. Their lordships affirmed the decision of the Court below and dismissed the appeal with costs.

LEGAL.—AN ELECTRO-PLATING QUESTION.—The case of "The Plating Company *v.* Farquharson (trading as the Nickel-Plating Company)" came before the Master of the Rolls and Lords Justices Baggallay and Lush recently. It was an action in which the plaintiffs sought to restrain an alleged infringement of their patent for nickel-plating by electricity. It appeared that in 1869 Mr. Isaac Adams, of Boston, in America, who had invented a process of nickel-plating by means of electricity, obtained a patent in this country, which was afterwards (in 1870) assigned to the plaintiffs, a limited joint-stock company carrying on business at Birmingham, Wolverhampton, and Sheffield. The plaintiffs contended that the defendants, the Nickel-Plating Company, were using at their works in Greek-street, Soho, the new process described in the plaintiffs' specification, and they claimed an injunction to restrain the infringement of the plaintiffs' patent.—The defendants put in issue the validity of the patent in the usual way, and also denied the infringement.—In the Court below Vich-Chancellor Bacon said it was proved that the possibility of depositing nickel on metal substances had been known for many years, but not as a commercial process of any utility before 1869. The plaintiffs took out a patent for a commercial process, and the defendants objected that there was nothing novel in the specification. He was of opinion that the objection entirely failed. He held that the plaintiffs were entitled to the injunction asked for, with costs.—On the appeal by the defendants their lordships were of opinion that the Vice-Chancellor had entirely overlooked the fact that the patentee himself had abandoned the first part of his claim. Under the circumstances they held there was no evidence against the defendants to justify an injunction, and they therefore reversed the decision of the learned judge.

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THE EFFICIENCY OF ELECTRIC LAMPS.

BY PROFESSORS AYRTON AND PERRY.

(Reprinted from the *Engineer*.)

(Continued from page 38.)

This is further shown by the first results of Table IV., but in the remainder of the table it will be found that our photometer gives sometimes more than 1½ times the answer which the direct method gives, and, as a rule, more discrepancy than this is observed with stronger lights. We have found that with strong lights sometimes we obtain the most varying results by the direct method, and at other times we get most consistent results. We are still investigating this matter, and although we are not yet prepared to state completely all the causes of the different results given by the two methods, we have proof that our method gives a nearer approximation to the light actually given out by the lamp; and this greater accuracy of our method arises from our measuring it at a place which is nearer to the lamp without introducing the error which would necessarily arise in the measurement of the small distance of the candle if an attempt were made to experiment on a strong electric light with a Rumford photometer put as near the lamp as we place our instrument.

As we have said, we are engaged in a complete investigation of this matter, and we content ourselves with here giving a few results obtained, in Table V., on the 7th Nov., in a room which seemed to have a perfectly clear atmosphere. In making these observations the three observers were continually being changed from one photometer to another, and the letters attached to each measurement denote the three observers. The numbers indicate what we have found to be a pretty general rule, namely, that Rumford's method of long distances gives a smaller result for the power of the light itself, sometimes much less than half the result obtained simultaneously in the same direction by the same method at shorter distances.

In an arc light the result may be partially caused by the fact that the intensity of the light in different directions, in the same vertical plane, is quite different, so that although care has been taken to place the near and

TABLE IV.—*Experiments on the Maxim Incandescent Light, at the City and Guilds of London Technical College, Finsbury.*

Ayrton and Perry's Photometer. 89in. from lamp. Candle-power.		Rumford's method. D = 219·5 values of *d* in inches.		Rumford's method. Candle-power.		Ratio of lens method to Rumford's method.		Mean Red.	Mean Green.	Ampères.	Volts.	Horse-power.	Candles per horse-power.		Mean candles per horse-power.	Remarks.	
Red.	Green.	Red.	Green.	Red.	Green.	Red.	Green.						Red.	Green.			
35	37	39·2	38·5	31	33	1·1	1·1	33	35	2·42	57	·185	178	189	183	Lamp No. 1. 26th October, 1881. Red measured before green. Observers change places.	Students reading one of the photometers.
31	36	44·0	41·5	25	28	1·2	1·3	28	32	2·42	57	·185	151	173	162	Green before red. Observers change places.	
85	106	25·9	21·5	72	104	1·2	1·0	78	105	3·07	67·6	·28	279	375	327	Red before green Observers change places.	
147	262	18·9	15·2	135	209	1·1	1·25	141	235	3·65	76	·37	381	635	508	Red before green. Lamp observed to be blackening, due to volatilisation of carbon filament.	
154	187	16·8	14·8	172	220	0·9	0·85	163	203	3·7	76	·38	429	534	482	Red before green.	
246	262	16·8	...	172	...	1·4	...	209	...	4·13	89·1	·5	413	...	...	No green. Rumford measurement taken.	
...	278	...	14·3	...	237	...	1·1	...	257	4·16	89·1	·5	...	514	...		
206	...	16·0	...	188	...	1·1	...	197	...	...	...	...	...	...	...	This lamp broke on putting on 80 cells.	
					means	1·1	1·1										
		D = 219·5														Lamp No. II. 26th October, 1881.	Students reading both photometers.
114	147	24·5	21	80	109	1·4	1·3	97	128	3·01	67·2	·271	358	472	415		
126	203	24	22·5	84	95	1·5	2·1	105	149	3·01	67·2	·271	387	550	468		
220	339	17	15·25	167	207	1·3	1·6	194	258	3·54	78·9	·374	519	690	604		
233	339	18	14·5	149	229	1·6	1·5	191	284	3·54	78·9	·374	511	742	626		
456	647	10·5	9·75	437	507	1·0	1·3	446	577	3·98	86·7	·462	965	1249	1107	Lamp seriously clouding.	
351	539	12·5	10·5	308	437	1·1	1·2	329	428	3·93	,,	,,	712	1056	884	〃	
317	422	15·5	13·5	201	264	1·6	1·6	259	343	3·98	,,	,,	561	742	651	〃	
305	377	16·25	13·0	182	285	1·7	1·5	243	331	3·98	,,	,,	526	716	621	The lamp now broke.	
					means	1·4	1·5										
																Lamp No. III. 26th October, 1881.	Students reading both photometers.
228	297	17	14	167	246	1·4	1·2	197	271	3·68	77·7	·383	514	707	610		
438	589	15	11·5	214	364	2·0	1·6	326	476	4·10	86·4	·475	685	1002	843		
438	589	15·25	12·5	207	308	2·1	1·9	322	448	4·10	86 4	,,	673	943	810		
713	790	12	9·5	334	544	2·1	1·5	523	667	4·49	95·0	·571	916	1168	1042	Lamp clouding.	
589	713	13	11·0	285	363	2·1	1·9	437	538	,,	,,	,,	765	942	854	〃	
598	646	14·5	11·0	230	363	2·6	1·8	414	504	,,	,,	,,	725	883	804	〃	
					means	2·05	1·65										
		D = 225·5														Lamp No. III. 2nd November, 1881.	
...	...	22·25	19·5	103	134	...	...	...	...	3·84	86·7	·446	231	300	265	Lamp now broke.	
		D = 228														Lamp No. IV. 2nd November, 1881.	Students reading both photometers.
130	136	25·37	23	81	98	1·6	1·4	106	117	2·94	68·4	·269	394	435	414	Red measurement made first.	
228	380	17	14	180	266	1·3	1·4	204	323	3·54	78·9	·374	545	864	704		
380	692	14·5	13·5	247	285	1·5	2·5	314	489	4·24	85·8	·488	643	1002	823		
547	692	10·5	11·5	471	393	1·1	1·7	509	543	4·38	96	·564	902	963	933		
...	973	...	9·5	...	576	...	1·7	...	775	4·8	108	·695	...	1115	...	Lamp now broke.	
					means	1·4	1·7										
1118	...	9	...	641	...	1·8	...	880	* ...	5	104·4	·7	1257	...	...	Lamp No. V. 2nd November, 1831. Broke after first measurement.	

* In order to measure the efficiency of Lamp No. V. for high electromotive forces before the clouding arising from the evaporation of the carbon filament had taken place, 90 Grove cells, producing a difference of potentials of 104·4 volts at the two sides of the carbon filament, were at the commencement attached to this lamp. One measurement was taken when the lamp broke.

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distant photometers in the same horizontal plane with the arc, an error in placing the near photometer is more important than an error in the distant one, if the illuminated areas to be looked at are of the same size. This is the case when the Rumford or any ordinary distance method is employed, and evidently furnishes another reason why such a method must be inaccurate at short distances. But with the dispersion photometer this difficulty is not introduced, since the effect of the lens is to place under examination much the same small pencil of rays, however near it may be to the lamp. It will be observed that this difference, arising from the distance of the photometer, is as well marked in the long series of experiments that we have made with the Maxim incandescent light, and as it is not probable that there is any such great difference in the intensity in different directions with an incandescent lamp, it follows that some other cause must be sought. That the effect in question may be produced by dust particles of a very minute kind floating in the air we think highly probable, for our experiments show, first, that the greater the intensity of the light—that is, the greater the proportion of blue to red rays—the greater is this difference; secondly, that the difference is more marked when the experiment is made through green than through red glass, both results leading to the same conclusion, that it is the highly refrangible rays which strike the first screen, and which never reach the second screen at all, that cause the difference. But if this which, nevertheless, fluctuated somewhat, although the engine and dynamo machine were running fairly regularly. Only horizontal rays, as nearly as possible in the same azimuth, were received on the photometer screens, which in this and other similar experiments were each composed of a sheet of white blotting paper, and yet it will be observed that there is but a bad agreement in the results, even although no observations were taken unless the light seemed to be temporarily steady, and although each set of observations was made quite simultaneously on a signal being given. It is also to be observed that there are no such great variations in the horse-power expended in the arc as there are in the light, although both the Am-meter and Volt-meter being very dead beat recorded every change in current and electromotive force.

From this it is quite clear that if one photometer only had been employed, and if only some three or four observations had been taken, the conclusion that would have been arrived at regarding the efficiency of the light, or number of candles per horse-power, would have depended very much on the distance at which the photometer happened to be placed from the light, and on which of the many results contained in Table VI. happened to be those included in the experiment.

A careful distinction must be made between such fluctuation effect as is shown in Table VI. and the variations due to the rays of light to the photo

TABLE V.

Foucault-Duboscq Lamp. Comparison of Ayrton & Perry's Photometer, with Rumford's Method of Measurement, 7th November, 1881.

	All through Red Glass.			
Dispersion photometer, 81in. from lamp.	Rumford's method. Screen 225in. from lamp.		Rumford's method. Screen 609·5in. from lamp.	
Candle-power.	Distance of candle.	Candle-power.	Distance of candle.	Candle-power.
1005a	6·9	1063c	25·7	562p
686a	7·6	876p	24·5	620c
756p	8·0	790a	23·75	658c
660p	8·25	743c	25·2	615a
643c	9·1	610p	24·6	615a
702c	10·0	506p	...	...
means } 742	...	765	...	608

The letter affixed to each measurement is the initial of the observer, who usually went to another instrument as soon as he had made an observation, in order that personal errors might be eliminated. Each observer carried his red glass with him.

TABLE VII.

Ayrton and Perry's Photometer, 115½in. from lamp north.	Rumford's method. Screen 121in. from lamp south.	Rumford's method. Screen 343in. from lamp east.
...	849	334
469	756	364
371	563	366
360	815	645
629	622	371
571	648	333
means } 480	703	449

TABLE VI.

Simultaneous Measurements made on a Serrin Lamp worked by a Dynamo, 16th November, 1881.

Ayrton and Perry's Photometer, 150in. from lamp.		Rumford's method. Screen 300in. from lamp.		Rumford's method. Screen 600in. from lamp.		Electromotive force in Volts between the two terminals of lamp.	Current in Ampères flowing through the lamp.	Horse-power expended in arc.
Red.	Green.	Red.	Green.	Red.	Green.			
857	1406	1712	2975	856	1600	34	32·2	1·467
947	1406	1246	3600	900	1406	34	29·4	1·339
576	...	1406	3600	946	1773	34	26·6	1·283
947	...	1498	...	997	...	34	26·6	1·283
1630	6100	1406	7625	779	2130	32	28	1·200
1277	2944	1406	7625	900	3600	32	30·8	1·321
900	1201	1406	3600	1052	2339	32	28	1·200
900	1655	900	1837	638	1283	32	29·4	1·261
1143	3115	1837	3600	1024	2608	32	29·4	1·261
2194	2975	1111	3600	997	3265	32	29·4	1·261
		Screen now put 48½in. from lamp.						
...	5933	2070	4384	1111	3600	31	30·8	1·279
1175	3425	1914	3836	1210	4208	31	29·4	1·221
1143	3115	1544	4096	1837	3989	30	29·4	1·182
1052	5993	1264	4384	857	4445	33	26·6	1·176
1363	...	769	...	1246	...	...	...	...
means } 1128	3294	1433	4212	1023	2810	...	...	...

is the case then it must be quite evident that in comparing the efficiencies of electric light—that is, the number of candles per horse-power—the lights ought to be measured at short distances, such as the three or four feet we employ, rather than the much longer distances necessary for accurate measurements by any of the ordinary direct methods. The loss which is caused by absorption or by reflection from the minute dust particles in the air is undoubtedly a most important question, but is really a distinct inquiry, since it would obviously be most unfair that one electric light should be said to give fewer candles per horse-power than another, simply because in the many feet of air between the light and the distant Rumford's shadow photometer there happened to be greater dust absorption or reflection on the day the one experiment was made than on the day when the second was carried out.

When measuring the strength of the lights at Paris, we were not able to extend our experiments on each lamp over a sufficient length of time to obtain an average result independent of fluctuations of the light, due to the adjustment of the lamp not being the best of the particular strength of current passing through it. The observations given in Table VI. were made simultaneously with three photometers in the City and Guilds of London Technical Laboratory by competent observers, a Serrin lamp which had been carefully adjusted being employed, but the light from meters being in different azimuths. For example, Table VII. shows the results of simultaneous measurements made in the same horizontal plane as the arc, the lens of the dispersion photometer being placed 115½in. north from the lamp, one of Rumford's screens 121in. east from the lamp, and the other 343in. south. At the shorter distances the measurements by Rumford's method for the stronger lights are rather inaccurate, as the candle was sometimes less than 5in. from the screen, and therefore its exact distance could not be determined with great accuracy. The lamp was a Foucault-Duboscq in good adjustment, and we used 100 Grove's cells so as to get a steady current. All measurements were made through red glass, and the observers changed places after each measurement, carrying their pieces of red glass with them.

Finally, therefore, we may conclude that to measure the efficiency of any special electric lamp, or number of candles it can give per horse-power expended in it, requires that a very considerable number of experiments should be made on that one lamp, burning apparently under constant conditions in order to eliminate atmospheric absorption and irregularities of burning which are not accompanied by variations in the amount of horse-power spent in the lamp.

W. E. AYRTON.
JOHN PERRY.

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THE STORAGE OF ELECTRICITY.*

BY S. P. THOMPSON, B.A., D.SC.

(Continued from page 39.)

Faure's Accumulator.

In 1880, M. Camille Faure conceived the idea of constructing a secondary battery, in which, though the tedious process of "formation" by Planté's process is modified and shortened, the ultimate result is the same, namely, to produce upon lead plates, immersed in dilute sulphuric acid, a coating of peroxide of lead, that can readily be reduced to the loosely crystalline metallic condition. This M Faure accomplishes by the device of giving to his leaden plates a preliminary coating of red lead (minium), made up into a paste with dilute acid, and painted upon the surface. The present mode of construction is as follows:—Eleven sheets of lead of such thickness as to weigh about 2lb. to the square foot are cut to the size of 12 inches by 10 inches, an ear-piece being burned on at one corner. Or six sheets are taken; five of them being twice the above size, and folded double, in the way shown in Fig. 4. These are painted thickly with red lead on both sides, and against each side is pressed a piece of felt, the object of which is to hold in its place the red lead, there being about 17lbs. of lead and 23lbs of red lead altogether. These sheets are placed side by side in a water-tight case, alternate sheets being connected together by the projecting flaps. The general aspect of the cell is shown in Fig. 5. The cell is filled up with dilute acid, the total weight being about 50lbs. When thus prepared, the cells are "formed" by a process of charging by means of the current of a dynamo-electric machine, the current being sent through them for six or seven days without intermission before they are ready for use. The red lead is reduced gradually on one side to the metallic state, and on the other assumes the condition of peroxide: but the cell does not attain its best condition for some weeks. As it is important that the electromotive force of the charging current should not much exceed that of the cells (2·38 volts), it is usual to charge a number of cells in series. The internal resistance of such cells is stated as being less than ·01 ohm. The advantage of this system of construction is not confined to the saving in time of formation, there is the further advantage of thus obtaining a much thicker film of the working substance than in the Planté accumulator, though with the difference that the deposit of peroxide is not so regular in its structure. According to Sir William Thomson, a single cell of the spiral form weighing 75 kilogrammes (165lb.) can store 2.000,000 foot-pounds of energy, or one horse-power for one hour. Their action is more economical, however, when the charge is not drawn upon at this rapid rate. Economy in working is found to accompany slow and regular discharge. Five or six hours is a more economical time for discharge, and then the waste is believed not to amount to more than 10 per cent. Sir William Thomson states that the probable loss of energy in charging is 10 per cent., and in discharging 15 per cent., but he thinks it will be advisable in practice to be satisfied with less perfect economy than this. According to Reynier, a Faure cell, containing 56 kilogrammes of lead, can store 210,000 kilogrammètres of electro-chemical energy; or at the rate of 3.750 kilogrammètres per kilogramme of lead, or 12,850 foot-pounds per pound of lead. According to M. Géraldy the figure is slightly less, being only 3,280 kilogrammètres per kilogramme, or 10,760 foot-pounds per pound. Such a cell, when on short circuit can, I am informed, furnish for ten hours a current of 10 to 14 webers continuously.

M. Faure is now constructing larger cells, of which, by the kindness of Major Ricarde-Seaver, I am enabled to give the following details:—The leaden plates are about 17 inches long by 12½ wide. About 51 pounds of red lead are used, and the 16 sheets of lead themselves weigh about 30 pounds. The sheets which are to serve as positive electrodes are eight hundredths of an inch thick. Those which are to serve as negative electrodes are four hundredths of an inch thick. After being painted with read lead they are folded up, first in parchment paper, and then in felt, and placed in a rectangular box, with narrow strips of india rubber to prevent contact. Such a cell requires about 16lb. of dilute sulphuric acid to charge it. The total weight is about 135lb. for each cell. One of these cells, when placed on a circuit of small resistance, in which one of Ayrton and Perry's galvanometers was included, gave the following values of current:—

For 8 hours	22 webers	=	176	weber-hours.
4 ,,	21 ,,	=	84	,,
1 ,,	20 ,,	=	20	,,
1 ,,	19 ,,	=	19	,,
Total 14 hours.			229	

or on an average over 20 webers continuously for 14 hours. The discharge went on after this for seven hours more, when it had stopped to five webers.

De Meritens' Accumulator.

Another modification of the Planté accumulator has been devised by M. De Meritens. In this cell the plates of lead are made up of thin laminæ, folded one upon another like the leaves of a book, or, more strictly, like the laths of a venetian blind, the whole being soldered to a stouter framework of lead.

Other Modifications.

I have found that almost any oxide or hydrate of lead will answer instead of red lead for the purpose of providing, as in the Faure cell, a material to be converted by a process of formation into the peroxide of lead. Litharge answers well if sufficiently finely divided before being painted on. White lead will even answer, but not so well. Litharge mixed with a small proportion of binoxide of manganese works well. The formation is rapid, but at first the electromotive force is not so high as in the Planté cell. It rises, however, as the process of formation proceeds. The binoxide of manganese is not so strongly electro-negative a substance as the peroxide of lead. Its presence in the final state would lessen the electromotive force. But happily the manganese gradually dissolves into the acid when its function as an agent to assist the lead in peroxidising is fulfilled, and by changing the acid a few times it is finally eliminated. The most satisfactory cells I have yet tried were made by painting the lead plates with a coat of the brown peroxide itself, which is obtainable in commerce, though its cost is about four times that of red lead or of litharge. I find this process by far the most expeditious for making up cells; as, indeed, might be expected, since it is obviously a stage towards simplification to put on to the lead plates a coating of the very substance which we desire ultimately to produce there. Examination of the plates of a cell in which the process of formation has only just begun shows that the lead surface must itself be peroxidised and bitten into before the useful action extends to the contiguous portions of oxide or peroxide painted over it, and in some stages a yellow suboxide, probably essentially litharge, appears to be produced as an intermediate product of the reduction of the oxide at the cathode. Of this intermediate yellow product, however, I can find no trace in well-formed cells. As the reduction and peroxidation of the coating only begins where peroxidation of the leaden sheet has begun, the relation of density to maximum polarisation, pointed out in an earlier paragraph of my paper, becomes of extreme importance. Plenty of current, and yet if an electromotive force only just exceeding the maximum electromotive force of the cell is the rule for charging in the early stages of formation. Could spongy lead be produced by any simple metallurgical process—like the spongy iron of Bischoff's filters—it would probably prove an admirable substance from which to form electrodes for accumulators. Professor Thompson then read a brief comparison of Planté's and Faure's accumulators.

Application to Electric Lighting by Incandescence.

Careful and precise measurements have been made by Sir William Thomson and Mr. J. T. Bottomley, using from 20 to 70 Faure cells as a source of current to illuminate some of Swan's lamps. These measurements have shown that the efficiency is very considerable, and that where from 35 to 50 such cells are available, the light produced by one lamp may range from 300 to 400 candles per horse-power, the latter being measured as actually consumed in the lamp. The foregoing statistics of one series of experiments are taken from the paper read by Sir William Thomson at the meeting of the British Association at York, September, 1881. From these experiments it appears that a high degree of economy in lighting by incandescent lamps is really attained. Should the accumulator be further improved, to reduce the percentage of waste between charging and discharging, accumulators will play a very important part in future installations, provided they can be constructed at a prime cost, lower than the present figures.

Swan Lamp, No. 1.

No. of experiments.	Cells.	Volts.	Webers.	Volts × webers ÷ 10 = kilogrammètres.	Horse-power.	Candles.	Candles per horse-power.
1	26	56·9	1·21	6·88	·093	11·6	125
2	30	65·5	1·46	9·56	·129	25	194
3	32	70·2	1·64	11·51	·156	42	263
4	33	71·8	1·74	12·48	·170	38	224
5	34	74·1	1·81	13·42	·181	44	243
6	35	76·1	1·82	13·86	·187	55	294
7	36	78·0	1·99	15·52	·210	63	300
8	37	80·3	2·06	16·54	·224	66	295
9	38	81·9	2·06	16·88	·228	76	333
10	39	84·6	2·06	17·43	·235	82	349
11	40	87·0	2·10	18·27	·247	84	340
12	42	90·9	2·17	19·72	·267	102	382
13	44	92·0	2·11	19·96	·270	89	330
14	46	99·1	2·27	21·91	·296	114	385

Carbon of lamp broke with same power immediately after the measurement of the light was completed.

At the Paris exhibition of Electricity, Faure's batteries have been doing excellent work. The following details of the separate installations will give an idea how many cells are required for a given number of Swan's lamps:—

	Swan lights.	Faure cells.
Vestibule	23	56
Kitchen	4	
Bath room	2	
Telephone Room (No. 7)	17	29
Telephone Room (No. 8)	18	29
Exhibit of the Compagnie La Force et La Lumières	34	56

Maximum Temperature Attainable by a Cell.

In connection with the subject of obtaining a high temperature by means of a cell, it may not be out of place to point out that the very high electromotive force of these accumulators (about 2·2 volts), exceeding that of any single cell of any other kind, carries with it the possibility of obtaining with such a cell a higher temperature than can possibly be obtained by a cell of lower electromotive force. This discovery is due to Lorenz, of Copenhagen, who, in a very remarkable paper published (in *Wiedemann's Annalen*) in August last upon "The Relation Between the Conducting Power of Metals for Heat and for Electricity," has shown that the highest possible temperature which a cell can raise any part of its circuit is proportional to its electromotive force. The highest point to which a Daniell cell, however large, can raise a conductor is, according to Lorenz, 3,327° above the zero of the Centigrade scale. The limiting temperature for a Planté or a Faure cell is 6,927°.

Application to Utilisation of Wind and Water-power.

And, lastly, though by far the most important of all the innumerable possibilities opened out by the storage battery, is its application to the

* A Paper read before the Society of Arts, Wednesday, Nov. 23, 1881.

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problem of utilising and transmitting the energy derived from wind or water-power. The difficulty of utilising water-power is that it is so often not to be found where it is desired; the difficulty with power is that it fails too often just when it is wanted. The reversibility of the dynamo-electric machine solves the difficulty of the where by giving us a means of electric transmission. The reversibility of the voltaic cell will probably solve the difficulty of the when, by giving us the means of storing energy, when we can get it, until such time as required for use. The accumulator will probably play an important part also in the distribution as well as in the storage of power transmitted from a distance, and thus become the ally of the dynamo-electric machine. It is certain that we cannot, with our diminishing coal-fields, long afford to neglect these other sources of natural power. In his presidential address to the Mathematical and Physical Section of the British Association, Sir W. Thomson has dealt with this question, and has come to the conclusion that, though tidal power be practically unlimited, it will not pay economically to build tide basins to utilise this power, as the reclaimed land would be of greater productive value, and that, therefore, we must not look to the tides. If I may venture modestly to differ from so great an authority, I would point out that there are cases where no great expense would be incurred in prove adequate to the purpose, the future must decide. Probably the present accumulator bears as much resemblance to the future accumulator, as a glass bell jar, used in chemical experiments for holding gas, does to the gasometer of a city gas works, or as James Watt's first model steam engine does to the engines of an Atlantic steamer. When the practical accumulator of the future has been built, it will be more easy to say what will be the limit of its applications. There are, as I have sufficiently shown, immense possibilities in store. Electrical railways and electrical tramways are now existing facts. Many months will not elapse—or it will be an eternal disgrace to the first city in the world—before the fœtid and poisonous atmosphere of the Metropolitan Railway is replaced by a pleasant and salubrious air, rich in fragrant ozone; and the like revolution will not be long delayed in many quarters where reform is far less imperative. In all these changes the accumulator will have its part to play. A reserve of electrical energy stored till wanted will be a necessary part of all systems for electric distribution, whether for purpose of lighting or motive power.

In conclusion, I would point out how the invention of the accumulator for storing the energy of electric currents has arisen out of the study of an obscure and unpromising detail in the science of electricity—the phenomenon of so-called "polarisation." Regarded by most experi-

Table of Electromotive Force as Calculated from the Heat of Oxidation of the Chemical Equivalent (H = 1 *Gramme*), *and as observed by Direct Experiment.* (The following is the table referred to in the first part of the Lecture.—*see* p. 23.)

Name of Substance.	Heat Value.	E.M.F.	Electromotive Force observed in Dilute Sulphuric Acid.				
	Calories	Volts.	With Oxygen.	With Platinum.	With Ozone.	With Peroxide of Lead.	With Zinc.
Potassium	63,800	3·04	...	3·17 (Buff) 2·484 (Wheatstone)	...	3·528 (Wheat.)	−1·144 (Wheatstone)
Sodium.....	67,800	2·95	...	...	...	...	...
Zinc	42,700	1·862	1·873	1·516 (Poggendorff) 1·439 (Wheatstone) 1·67 (Beetz) 0·637 (Raoult)	...	2·448 (Wheat.) 2·93 (Joule)	0
Iron	34,120	1·570	...	...	...	...	[0·600 (Ayrton & Perry)]
Hydrogen	34,100	1·493	(?)1·64 (Tait)	0·86 (Raoult) 0·877 (Beetz)	1·9 (Raoult) 2·1 (Wheatstone, Poggendorff, Svanberg) 2·3 (Buff, Tait) 2·265 (Bartoli, Beetz)	(?)2·78 (Planté)	...
Lead.....	25,100	1·133	...	...	...	2·38 (Planté)	[0·21 (Ayrton & Perry] 0·55 (De la Rue)
Copper	18,760	0·818	0·74 (Raoult)	0·550 (Raoult)	...	...	0·953 (Poggendorff) 1·079 (Latimer Clark) ·978 (Latimer Clark) [0·75 (Ayrton & Perry]
Silver	(?) 9,000	...	...	...	...	...	1·546 (Poggendorff) 1·439 (Wheatstone) 1·67 (Beetz) [0 981 (Ayrton and Perry)]
Platinum	7,500	0·327	...	0	1·21 (Raoult) 1·04 (Raoult)	0·6 (Raoult) 0·75 (Raoult) 0·90 (Wheat.)	
Carbon.....	(?) 2,000	...	...	...	1·435 (Lenz, Sawoljew) 1·18 (Raoult)	...	[1·096 (Ayrton & Perry)]
Oxygen	0	0	0	...	...	...	...
Nitric Peroxide	−6,000	−0·29	...	...	...	...	1·97 (Buff) 1·95 (Latimer Clark) 1·96 (Sabine)
Chromic Peroxide	−7,195	−0·31	...	...	...	...	2·028 (Sabine)
Manganese Peroxide.....	...	...	...	−0·54 (Wheatstn.) −0·101 (Raoult) −0·128 (Raoult) −0·404	...	0·504 (Wheat.) 0·426 (Joule)	1·944 (Wheatstone) 2·55 (Joule)
Lead Peroxide..	...	...	...	−0·6 (Raoult) −0·75 (Raoult) −0·90 (Wheatstn.)	...	0	2·448 (Wheatstone) 2·93 (Joule) 2·1 (D'Arsonval)
Silver Peroxide	...	...	...	−0·7 (Raoult) −0·86 (Raoult)	...	...	...
Hydrogen Peroxide	−10,800	...	...	...	...	...	...
Ozone	−14,800	−0·645	...	−1·04 (Raoult) −1·21 (Raoult)	0	...	...

Ayrton and Perry's observations, being made with an electrometer for contact in air, are placed in square brackets, as not being, like the rest, observations on the electromotive force in sulphuric acid.

utilising natural tidal areas as basins, where the area so utilised could not possibly be reclaimed or worked as profitable land, and where the rise and fall of the tide is greatly above the figure which he assumed. The River Avon at Bristol furnishes a case in point. It requires but a few yards of embankment to be turned into an available tidal area. The average rise and fall of tide at the city of Bristol, five miles from its mouth, is 23ft. According to calculations I have made from the average volume of water displaced up and down each tide, there are no fewer than 20 billions of foot-pounds of energy wasted every year, or enough to charge ten million Faure cells. At the mouth of the river the total annual tidal energy thus running to utter waste cannot be less than 50 billion foot-pounds; and in the rapid currents of the River Severn, with their enormous tides of great volume, the tidal energy must be practically unlimited. A tenth part of the tidal energy in the gorge of the Avon would light the city of Bristol. A tenth part of the tidal energy in the channel of the Severn would light every city, and another tenth would turn every loom and spindle and axle in Great Britain. But the power would have to be not only transformed and transmitted, but stored, to be available for such ends. Accumulators are therefore a necessary feature in any scheme to utilise the intermittent forces of the tides. Whether the present form will menters merely as a trival but disturbing fact in the construction of voltaic batteries, to be put down or got rid of by whatever means, it has been developed, and mainly by the long and patient researches of one man (M. Gaston Planté), and finally, by the brilliant idea struck out by M. Faure, been turned into one of the most fertile and promising features in the development of the science. It is the old story over again of the reward which follows patient investigation of unexplored corners and waste places of science. Grand principles and sweeping generalisations are magnificent weapons to the scientific investigator. The principle of the conservation of energy has reaped triumph after triumph, and a kindred generalisation in the science of electricity is destined, as I think, to lead to scarcely less important results. But there are other ways of adding to the sum of human knowledge beside the following out of grand sweeping principles. There are half-forgotten observations, unconnected, unexplained, and often exceptional in character, every one of which has a significance of its own—residual phenomena, every one of which is, to the scientific man, of a value beyond price. He who investigates them patiently may find the clue to their meaning, and reap a rich reward from them. They are the finger-posts on the high road of scientific discovery.

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THE RESPONSIBILITY OF CABLE COMPANIES.

The discussion of all the responsibilities of cable companies would require a large volume, and we have neither the desire nor the leisure to enter upon the general question. Our remarks will be confined, just now to one part of the question upon which the law courts in the United States have been called upon to decide. The decision, it must be remarked, has been more than once appealed against, but consistently and persistently it has on each occasion been confirmed. The physical conditions under which submarine cables exist should always be kept in mind when discussing the correct transmission of messages. Most of our readers understand the difficulties encountered in working long cables, from inductive action, from earth currents, from slight faults, from the delicacy of the instruments, not to mention the graver and more expensive difficulties from total rupture of the cable by earthquakes, by storms, by ships' anchors, and so on. No cable company could unreservedly guarantee to perform certain operations, for the simple reason that it cannot control the apparatus by the aid of which it is enabled to perform the work. It is also necessary to bear in mind the method employed in transmitting signals, and how easily, yet unavoidably, it may happen that the signal indicating one letter may be substituted for the signal indicating the letter it was intended to send. All who would become acquainted with the possible transformations of telegraphic signals should study the pamphlet on the subject issued by the Eastern Telegraph Company, or the report of the Postal Telegraphic Department. From the latter it will be seen that many ludicrous and some grave mistakes occur in the sending of signals on the much more manageable land lines. From the former it will be seen that the loss of a dot or short signal, which, as previously stated, may unavoidably occur, changes the letter to be indicated, as does the lengthening a space or interval between two signals. The loss of a short signal, for example, turns H into S, thus, _ _ _ _ H; _ _ _ S; while an error in spacing converts B into T S, thus, _ _ _ _ B; _ T, _ _ _ S, and so on.

It may be asked why cable companies use a method of signalling containing chances of error, but the answer is very simple—that as yet no one has discovered a better method of signalling or one that presents so few chances of error. If the critics who declaim against the work performed by these companies would invent a better method, the companies would be only too glad to adopt the system.

These preliminary remarks are necessary for the right understanding of the case before us. On the 6th November, 1875, Julius Hart sent a message from New York to Albert Herz at Stuttgart, in Germany. The message, as written on one of the Direct United States Cable Company's forms, reads:—"Unsaleable account Missouri Pacific troubles. Hatch says hold undoubted." This message reached Mr. Herz in the following shape:—"Unsaleable account Missouri Pacific troubles. Hatch says sold undoubled." On receipt of this message Herz proceeded to sell certain securities belonging to Hart, the result being a loss of between 2,000 and 3,000 dollars, for which loss Hart sued the company. These telegraphic messages were in continuation of previous correspondence. Without giving the details of the matter printed upon every telegraph form of the company, information given with a view to obviate errors and prevent loss, we may direct attention to a part of the notice, which says: "For the better guarding against mistakes, every telegram of consequence should be repeated by being sent back from the station at which it is to be received to the station from which it is originally sent. Half of the original cost for transmission is charged for such repetition." The company in its defence justly dwelt upon the message as delivered being meaningless and senseless, and that it became the duty of the receiver of the message to ascertain its true meaning, and not to give a meaning of his own, or to put his own construction on words which were meaningless. The Court accepted this view, and agreed that the plaintiff's loss was caused by the negligence of his agent in selling upon receipt of a meaningless despatch. The agent chose to speculate upon the meaning of the telegram. Judge Van Brunt dismissed the complaint, the General Term affirmed this judgment, and in October last the Court of Appeal gave judgment to the same effect.

This action is very important as sharply defining in this direction the responsibilities of a cable company. It may do much also in making the general public more careful as to the wording of messages. Neither the direct nor the cross-examination could bring out any reason for the use of what we may call redundant words in this message, and we fail entirely in our effort to understand their necessity. Let us consider for a moment the two messages, viz., the one from Herz, and the one in reply from Hart. On Nov. 3 Herz telegraphs:—

"Joaquin unsaleable. Sell the twenty-three or what begin. Answer."

The reply sent from New York on Nov. 6 was:—

"Unsaleable account Missouri Pacific troubles. Hatch says hold undoubted."

The plain interpretation of the first part of the latter

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telegram is the sender argues that the securities are unsaleable, and the reason is given. The redundant part of the message seems really to have been sent to show that inquiries had been made about the securities, and that the inquiry had been satisfactory. Surely, however, a business man would understand that certain advice was not sent without due consideration, and in this case as a delay of three days elapsed between the first telegram and the answer it was clear the delay gave ample facilities for investigation. Even on the supposition that the last four words are necessary, we quite agree with the ruling of the Courts that by no means could they be perverted into an order to sell. It is, of course, always easy to prophesy after the fact, but it seems to us that the information in the telegram could have been given without danger of mistake. Suppose, for example, the words referred to had been "Hatch advises keep," they would have shown conclusively that Hart had made inquiries, and that the result of the inquiries was not such as to hurry on a sale at any price.

Our great object in calling attention to this trial and its result may again be stated, and it is that senders of telegrams should, whenever possible, use simple language, and endeavour so to word them that the meaning cannot easily be misunderstood. The cable companies will do their best to send correctly. It is in their interest to do so. The repetition of messages is not so eagerly sought after by the companies as some might imagine. So long as the wires are not fully employed the evil is not great; but when the line is blocked with messages, the repetition of telegrams means a loss of revenue, so that, as we say, the interest of the companies is in correct transmission.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

I.

In these articles we shall aim not at originality, but at instruction. It has seemed to the Editor that there is a large class of persons who know a good deal about dynamos practically, but who have not quite clear ideas about the fundamental physical principles which underlie them, and who would be very glad of some information of this kind in an accessible and intelligible form. Some amount of information of this kind is, indeed, already widely diffused among practical electricians, but it is somewhat unsystematic, and occasionally vague and unsatisfactory, a condition of things which renders it possible that a statement of principles *ab initio* may result in a clarification of ideas, even though nothing essentially new be imparted.

One of the most important and absolutely essential things is to define one's terms accurately and grasp the ideas connoted by them clearly, and this we shall strenuously aim at; but we will introduce these terms as we want them, in preference to giving a list of them at starting. Another essential thing is to understand clearly the principles of the system of absolute measurement and expression in mechanical units, which lies at the root of all accurate work in physics in recent years. One of the first ideas needful to be defined is that of a magnet and a magnetic pole; and as there is at the present time a theory of magnetism which is probably true, and which is very satisfactory as far as it goes, we shall make no apology for giving it here.

Constitution of a Magnet.

A non-magnetised magnetic substance is an assemblage of magnetic molecules, which are on the average facing equally in all directions, but which are capable of being rotated so as to face in any given direction by an act of magnetisation.

It has been shown experimentally (by Beetz) that the act of magnetisation does not consist in exciting magnetism in previously inert molecules, but in rotating molecules which are already magnets as powerful as they are able to be. Hence this part of the theory is certainly true.

A magnetic substance whose molecules, after having been faced round and left to themselves, all instantly swing back into their original position, is said to be perfectly soft, or to have no coercive force.

A magnetic substance is said to be hard, or to possess *coercive force*, or *retentivity*, in so far as the molecules when faced round along any direction, tend to remain more or less still facing in that direction. Such a substance is then called a permanent magnet.

When a substance has been strongly magnetised and left to itself, the molecules always partially swing back; in other words, the permanent magnetism is always less than the temporary.

They nearly always, however, remain *somewhat* deflected from their original position; in other words, there is nearly always *some* permanent magnetism, which when only small is spoken of as *residual magnetism*.

The elastic recovery and permanent set of the molecules presents an obvious analogy to the same things as observed in the ordinary straining of elastic material; and just as, if the straining force does not exceed a certain limit, the permanent set is almost inappreciable, so it is with magnetism. The residual magnetism does not assume important proportions till the magnetising force applied has exceeded a certain limit, depending on the nature of the material, which limit is low for hard and high for soft iron.

A *magnet*, then, is an assemblage of magnetic molecules of which some are facing more or less in one direction (straight or curved), this direction being called the axis of the magnet.

An *ideal simple magnet* is a magnet with only one axis. It is not necessary that the axis of every molecule in it shall point in this direction, because that would be an ideal simple magnet magnetised to saturation. All that is necessary is that the facing of the molecules in every other direction shall be *on the average* zero.

An *ordinary magnet* is a magnet with a number of axes, all ordinarily grouping themselves, more or less, about one direction—the principal axis. An ordinary magnet is thus a bundle of ideal simple magnets, much like a double birch-broom.

The axis need not in any case be straight: it is straight in a bar magnet, it is bent in a horse shoe.

The ends of an axis are called *poles*. An ideal simple magnet having only one axis has only two poles. An ordinary magnet has a number of poles, distributed like the terminals of the birch-broom filaments. The ends of its principal axis are, however, popularly spoken of as its poles. One pole cannot exist without the other, but a magnet may be of any length, and the other pole may therefore be kept out of the way. The only way to conceive of a single pole is to think of one end of an extremely long and perfectly flexible magnetised wire. It may easily be conceived as floating about freely like the loose end of a long fibre of cocoon silk.

An ideal *ring* magnet, if magnetised in the most simple way, has no poles, the axes being endless. An ordinary ring magnet so magnetised will have a number of little accidental poles scattered about, by reason of all the axes not being entire, but as it were broken, for accidental reasons. A ring magnet cut in half and pieced together again with one half reversed is in much the same condition as a bar magnet split open down the middle, and the two halves pulled out till it is ring shaped. It has, of course, two poles, and is, in fact, merely a double horseshoe. Such a magnet was the ring in the Paccinotti motor, and is now (with irregularities in shape) the electro-magnet of the Gramme and Siemens machines.*

An assemblage of magnetic molecules arranged end to end so that all their axes lie in one (straight or curved) line is called a magnetic filament.

An assemblage of magnetic molecules arranged side by side in two dimensions so that all their axes are parallel is called a magnetic *lamina* or *shell*.

* If we might make a suggestion to Prof. S. P. Thompson we would ask him to add to his very useful set of photographed magnetic curves those belonging to a Paccinotti ring; also, if practicable, to a Gramme magnet without and with the armature in position, and to a Siemens magnet. We should be glad to illustrate such curves.

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A telephone disc held between the large plane nearly touching surfaces of the pole pieces of a large electro-magnet is a coarse magnetic shell.

Given any closed curve or *contour*, a magnetic shell may be conceived of as filling it up, being bounded all round by the contour. One face of it will be all north pole, the other face of it will be all south pole.

A simple magnet, then, may be considered either as a bundle of magnetic filaments arranged side by side, or a pile of magnetic shells arranged end to end.

A magnetic molecule is a molecule with a two-ended or double-faced property whose nature is not certainly ascertained, but which, as Sir Wm. Thomson long ago pointed out as a deduction from Faraday's magneto-optic experiment, is certainly due to something of the nature of a rotation in the molecule. This rotation, according to the theory of Weber and Ampère, and to a high degree of probability, is nothing else than a current of electricity of unknown strength continually circulating in a perfectly conducting channel in the molecule. [The channel may or may not be co-extensive with the substance of the molecule.] The line round which this molecular current circulates is called the *axis* of the magnetic molecule, and the two ends of this line or axis are called its *poles*.

The two ends, or faces, or poles, of the molecule are not only physically inseparable, but are separately inconceivable, just in the same way, and for the same reason, as one side of a sheet of paper is inconceivable without the other equal opposite side.

The properties of a magnetic molecule have only at present been investigated when aggregated together in large numbers to form a magnetic substance.

The cause of the currents circulating in the molecule is unknown, and there is no known way of exciting them, or of increasing their strength. Their strength may be temporarily lessened, but cannot be increased beyond their normal amount.

When these molecular currents are normally strong, the substance is said to be strongly paramagnetic; when they are normally very weak, or even zero, it is said to be a diamagnetic substance.

It is probable that the molecules of *all* substances are perfectly conducting, and possess circulating currents; the normal strength of these currents varying in different substances, from bismuth where they are weakest, to iron where they are strongest.

If in any substance all the molecules are made to face accurately in one direction, that substance is magnetised to saturation, and it is impossible to magnetise it any more. It would, indeed, be probably weakened by any further increase of magnetising power. This last statement has not been yet experimentally established, but it has been predicted by Clerk Maxwell as a consequence of Weber's theory, and, if verified experimentally, will serve as an almost conclusive proof of the truth of that theory.

Indo-European Cables.—The two cables belonging to this company which were broken in the Persian Gulf, between Bushire and Kurrachee, on the 25th November, were repaired by the cable ship "Patrick Stewart," on the 4th instant. Direct communication with India is, however, still interrupted, owing to the break in the Post Office cable in the North Sea, the fault in which lies about 35 miles off Lowestoft. As the Post Office has no cable ship of its own, the date of the ultimate repair of this cable is problematical, especially as the only available ship, the "Lady Carmichael," is at work elsewhere. In another column we notice the case of a broken cable in Scotland, the repair of which does not, under present conditions, seem likely to be effected very soon. Is it not time that the Postmaster-General thought of having some ship prepared against emergencies of this sort? He has a great many cables under his control, but no means of repairing them, except by means of hired vessels, and when, as is the case at present, all the available cable ships are otherwise employed, he is unable to do anything, and valuable property lies idle at the bottom of the sea, whilst the public are put to great inconvenience.

SUBMARINE CABLES.

A further contribution to the correspondence on this subject in *The Times*, which we have reproduced in our last two numbers, appeared on the 6th instant, in the shape of a letter signed "One Interested," which reads as follows:—

"Public attention is being concentrated upon the interruptions to the great lines of telegraph, and the less important ones seem to attract no notice. These, however, are faring no better than the others, and although they are internal and not international, surely our own domestic lines are as worthy of attention as the more fussily-represented big international cables. The readers of *The Times* will remember that the Shetlands some time ago were cut off from all communication with the mainland for many months. This unpardonable negligence is now being repeated in the case of the Scilly Islands. For some months now these have been totally deprived of the use of the telegraph, owing to the breakage of the cable and to its being allowed to remain broken. No attempts have been made to repair it, and meanwhile the cables to the Isles of Arran and Rothesay have been interrupted, and still continue in that condition. In your leading article of the 9th of November you say, 'To prevent the occasional failure of a submarine cable is, of course, impossible; but when a breakage occurs the arrangements for repair should be swift and prompt.' I will now proceed to show you how admirably the actual arrangements of the Government correspond with your description of what they ought to be. Incredible as it may appear, the Postal Department has no cable-repairing steamship; consequently, when breakages occur, the Post Office has to charter a cable ship from one of the companies, and if no ship is disengaged the broken cables must remain broken until a ship can be found. Of course, the Scilly Islands and the Shetlands and such small fry must wait. Such is the case at the present moment, and this is one of the reasons why cables remain broken for months together. But suppose just now, when the Post Office finds all the companies' ships engaged with their own work, the direct Dublin cable were to break down and Mr. Forster to be deprived of his direct wire with Downing-street, and perhaps more breakages to follow on the back of the first, what would be the consequences and what would the public say then? The Government surely cannot be of opinion that to keep something like 600 miles of cable in proper repair they may trust to the chance of a suitable ship being found obligingly disengaged just at the moment their cable breaks. The public do not want a system of almost continual interruptions tempered by occasional repairs, and I would undertake to say that the difference of annual cost between chartering other people's ships and maintaining their own would be found by the Postal Department to be ludicrously small and absolutely insufficient to justify the present system, its cruel results to our isolated island peoples, and the grave consequences it may at any moment entail. In your leading article of the 23rd of November you justly remark, 'We are as much concerned in the preservation of our cables as in the safe custody and delivery of our mail bags.' Suppose the Government could not in any district hire mail carts because they were already engaged by other parties and that the department had none of their own, would they venture to suspend all postal communication with such districts for months together until carts were disengaged? No doubt economy is popular, but it is that sort of economy understood as judicious expenditure—not economy leading to miserable impotence and discreditable failure. If it was worth while to establish the island and other lines of submarine cable, then it is worth while, and, moreover, it is a public duty, to maintain them efficiently as well as all the other cable property of the country. It is nothing less than a public scandal that telegraphic communication, where it has already been established, should be deliberately suspended for months for the inadequate reasons stated. Anchors and fishing craft are not, as you will perceive, the only causes of delay in effecting repairs, although the difficulties they create and the delays they interpose make it the more necessary to throw no chance away."

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ON GALVANIC POLARISATION.*

BY PROFESSOR HELMHOLTZ.

In 1872 I wrote a paper on galvanic currents, which continue for a long time in an electrolytic cell, under the influence of an electromotive force, too feeble to effect electrolytic decomposition. I tried at that time to prove that the long duration of these currents was caused by oxygen dissolved in the water of the electrolyte, combining with the hydrogen, which is carried by the electrolytic motion to the cathode. So the oxygen, which existed formerly near the surface of the cathode, is taken away, and instead of it the same amount of oxygen is liberated at the anode. This can return by diffusion to the cathode, and so the same action can go on without end. It appears as a current producing no electrolytic action. I call it "electrolytic convection."

My experiments, published at that time, were performed with an electrolytic cell, from which the air was removed by a mercury air-pump; but I did not succeed in getting it absolutely free of air, because the lubricating grease of the stopcocks allowed some air to get in during the long time through which it was necessary to continue the experiments.

Lately I have had better results with a cell hermetically sealed, containing acidulated water and a vacuum, filled of course with vapour of water. Three electrodes enter the cell; two of them platinum wires, the third a thin platinum wire, to which a spiral of palladium is fixed. Before closing the glass tube through which I had introduced the liquid, I removed the atmospheric air left in the cell by means of a water air-pump, and sent an electric current through the cell, so that oxygen was evolved at the two platinum wires, and all the hydrogen was occluded in the palladium. Then I closed the tube with the blow-pipe. The traces of oxygen remaining in the interior of the cell combined again slowly with the hydrogen of the palladium, and even if I evolved new quantities of electrolytic gases in the interior of the closed cell, they could be removed again by the electromotive force of a Daniell cell, driving the oxygen to the platinum wires and the hydrogen to the palladium. On the contrary, I may charge the two platinum wires with hydrogen, if I connect them for a short time with the palladium wire.

If the platinum wires be freed from all hydrogen, a feeble electromotive force, of about 0·01 to 0·001 Daniell, gives only a very short deflection; then the galvanometer returns to zero. Removing the electromotive force without breaking the circuit, I saw an opposite deflection, equal in magnitude to the former and of the same duration. I have measured the capacity of the two platinum surfaces considered as condensers. They behaved like two condensers the two electric strata of which were separated by an interval of a ten millionth part of a millimetre. This is a capacity smaller than that found by Kohlrausch (1-15,000,000 mm. distance) and other observers. But I found that the capacity appeared to be much greater if only a small quantity of hydrogen were carried by an electric current to the platinum. The same was the case if the wires were newly polarised with oxygen, but this latter modification vanished some hours after the battery had been taken away. In these latter cases a part of the current produced by the external electromotive force must be considered as caused by electrolytic convection, and this part vanishes very slowly and never completely.

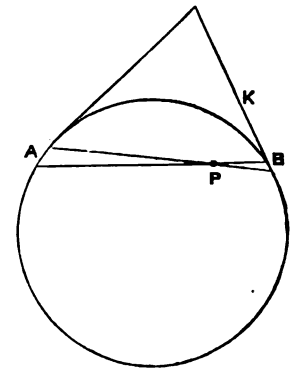
The quantity of electricity which was carried to the platinum electrodes when they were free of hydrogen was exactly proportional to the electromotive force applied to the cell, down to forces of 1-1000 Daniell. From this it is to inferred that no kind of chemical or molecular force exists in the interior of the electrolytic fluid, which is able to prevent the ions of the electrolyte from moving about in the interior of the fluid, till they have got the distribution required for the equilibrium of the electric forces. For if such a force existed, we ought to find an inferior limit to the electromotive forces, which are able to charge the electrodes like a condenser.

*. *Proc Royal Society of Edinburgh.*

ON THE PROOF OF THE LAW OF INVERSE SQUARE AS APPLIED TO ELECTRICAL ACTIONS.

That the attraction or repulsion between two elements of electricity varies inversely as the square of the distance between them is a law which forms the foundation of the whole subject of statical electricity. This, like other physical laws, is, of course, accepted on the strength of experiment and observation. Measurements with Coulomb's torsion balance may, perhaps, be considered to give the most direct experimental proof of the law within the (wide) limits of error to which such measurements are subject; but the highest experimental evidence on which we base an acceptance of this law is the fact that no electricity whatever can be detected on the interior surface of a closed hollow conductor, or on any body within the conductor and in metallic connection with it. Inasmuch as the quadrant electrometer enables us to detect the millionth part of a charge not greater than may conveniently be given to a conductor of moderate size, it follows that the law of electrical action may be put to a very severe test; far more severe than any which can be applied through the medium of the torsion balance. But the method, though almost immeasurably superior from an experimental point of view, must be admitted to be indirect, and students frequently find a difficulty in seeing the bearing of the experiments upon the law. The following may serve in some measure to elucidate this point, though it must be considered rather in the light of illustration than of proof. The first of the propositions will be found in most treatises on attractions.

Let the figure represent a spherical conductor, and let P be any point within it. The point P may be on the inner surface if the conductor be hollow. Suppose that a uniform layer of electricity is spread over the external surface of the conductor, and let us assume that the law of action is that of the inverse



square. With P as vertex describe a cone of any form, cutting from the spherical layer of electricity the area A and B. These areas are equally inclined to the axis of the cone, since the tangents to the sphere A and B are equally inclined to this axis. Also by similar figures

$$\text{Area A} : \text{area B} :: \text{A P}^1 : \text{B P}^2,$$

if e denote the quantity of electricity upon A, the quantity e' upon B will be denoted by $e\frac{\text{B P}^2}{\text{A P}^2}$, since the distribution is uniform over the spherical surface.

Now, consider the action of the charges at A and B upon an element of positive electricity at B P. If q denote the quantity of electricity considered at P, the repulsion exerted upon it by e units of electricity at A will be $\frac{eq}{\text{A P}^2}$, and that exerted by e^1 units at B will be represented by $\frac{e^1 q}{\text{B P}^2} = eq\frac{\text{B P}^2}{\text{A P}^1}\cdot\frac{1}{\text{B P}^2}$ $= \frac{eq}{\text{A P}^1}$. Hence, the two repulsions which are exerted in opposite directions along A B are equal, and the resultant force at P is, therefore, zero. But the whole of the spherical surface may be made up of the bases of pairs of cones similar to A and B, each cone having P for its vertex. Hence, the resultant force exerted at P by the uniform spherical shell of electricity is zero, and this is the case whenever P may be situated within the surface. Therefore, if a sperical conductor be uniformly electrified, and there be no electricity whatever within the conductor, there will be no tendency to produce electrical displacement at any point within the substance of the conductor. This result has been obtained on the assumption of the law of inverse square.

Let us now suppose that a different law obtains; for example, let the force between two charges vary inversely as the distance

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simply. Then the repulsion of the charge at A upon q units of electricity at P will be denoted by $\frac{eq}{AP}$, and the repulsion of the charge at B will be $\frac{e^1 q}{BP}$, or $eq\,\frac{BP^2}{AP^2}\cdot\frac{1}{BP}=eq\,\frac{BP}{AP^2}$. Clearly the former is the greater, and thus the repulsion of the more distant charge will exceed that of the nearer. A similar result will be found for every other pair of cones through P, and hence the resultant force upon positive electricity at P will tend to urge it towards the nearest point of the surface, *i.e.*, away from the centre, if there be no electricity within the sphere. Positive electricity will, therefore, go to the external surface, leaving the interior of the sphere charged with negative electricity, sufficient to balance the excessive repulsion of the more distant parts of the sphere upon a unit of electricity placed anywhere within the sphere. Thus, if the law of attraction were the inverse first power of the distance, the amount of positive electricity on the outside of any positively charged conductor would be greater than its actual charge, and negative electricity would be found within the interior of the conductor or of any body in contact with the conductor, and inside it, the conductor being supposed hollow. A similar result would be obtained if we suppose the law of action to be any inverse power of the distance lower than the inverse square, that is if the law be expressed by the formula $\frac{EE^1}{r^n}$ where n is less than 2.

Next, suppose the attraction or repulsion to vary according to some inverse power higher than the inverse square; the inverse cube, for example. Then the attraction of e units at A upon q units at P will be represented by $\frac{eq}{AP^3}$, and the attraction of e^1 units at B by $\frac{eq}{BP^3}$ or $eq\,\frac{BP^2}{AP^2}\cdot\frac{1}{BP^3}=eq\,\frac{1}{AP^2\,BP}$. Clearly the latter is in this case the greater, so that the repulsion of the near element at B exceeds that of the more distant element at A. The same result will be found for every other pair of cones having P for the common vertex, and thus the resultant force upon a unit of positive electricity at P will be towards the centre of the circle, if there be no electricity within the sphere. Hence, if the law of electrical action were that of the inverse cube of the distance, the charge on the outside of a positively charged conductor would be less than its actual charge, and positive electricity will be distributed throughout its interior, so as to balance at every point within the sphere the attraction towards the centre. A similar result will be found if the law be supposed to be that of any other inverse power of the distance higher than the second.

Hence, if there be absolutely no electricity within a charged spherical conductor, the law of inverse squares must be rigidly true.

PREPARING PIGMENTS BY ELECTRICITY.

For a long time past the idea has been entertained of employing the gases disengaged in electrolysis for preparing various chemical compounds, and Becquerel utilised the idea in the electrolytic preparation of inorganic compounds, while Frankland, Kolbe, and others reduced divers organic compounds, such as cinchona, by the same method. More recently M. Renard adopted the plan for producing derivatives of alcohol, and M. Naudin has applied it to the rectification of alcohol, as we have already described in our columns.

A more novel application than any of these is due to M. Goppelsrœder, of Mulhouse, and the first results of his researches was exhibited at the Paris Exhibition in the Swiss Section. This consists in the preparation of aniline colours from coal tar by means of electricity.

The possibility of preparing certain colouring matters by the action of the electric current was announced in 1875 by M. Goppelsrœder in a paper to the Industrial Society of Mulhouse. At that time the author had only prepared a small number of coloured compounds, chiefly the insoluble aniline black, also obtained about the same date and by the same process by M. Coquillon. Since then he has extended his researches, and has succeeded in producing a great variety of colour. The general process of preparation consists in submitting to electrolysis some water, acidulated if necessary, and containing in solution an organic body or mixture of organic bodies, susceptible of giving birth to a pigment, either under the influence of oxygen or hydrogen. It follows that the colouring matters are produced sometimes at the positive or the negative pole, and sometimes at both poles simultaneously.

The apparatus employed ought, therefore, to be arranged so as to prevent a mixture of the products formed at the two poles, not only because these are separately useful, but to prevent secondary reactions by diffusion.

The most simple disposition realising these conditions is also that which most of the above-cited experimenters have adopted for the electrolytic preparation of different organic bodies. It consists of a glass vessel, in which is placed a porous battery pot such as is used in the Bunsen battery, both being filled with the liquid to be reduced. A plate of platinum is connected by a screw terminal with the positive pole of the battery, and plunged in the porous pot; while a second plate of platinum of larger size is connected to the negative pole of the battery, and plunged into the exterior vessel. It is on this last plate that the product is usually deposited. Instead of a porous pot a cotton sack may also be used to sheath the negative plate, and the deposit dissolved out of it by alcohol.

In certain cases, to avoid yet more the mixture of the two matters, the inventor separates the liquid between two vessels connected by a cotton wick or other porous substance, such as a fold of Swedish filter paper enclosed in parchment paper to prevent evaporation of the liquid.

Sometimes M. Goppelsrœder places the larger plate in a porcelain capsule filled with the liquid, and the other in the bowl of a clay pipe, up the stem of which the platinum wire is passed. The gases disengaged by electrolysis at the positive pole can in this manner be led away by means of an india rubber tube.

Another arrangement destined to admit of collecting the gas consists in immersing the negative plate in a glass bottle, through the rubber cork of which the electrode passes. A bent glass tube also passes through the cork into the interior of the bottle, and by the tube the gas given off at the positive plate can be led away. The positive pole is formed of a platinum wire, which is let down into a kind of sprout, shaped like a dumb bell, and communicating with the bottom of the bottle. This also is filled with liquid, which communicates with that in the bottle through a stuffing of cotton wool in the neck of the sprout.

When the electrolysis has to be done at a heat the exterior vessel, itself is made in the form of a pan of sheet platinum, which serves for the principal or negative plate, and is connected to the battery by means of terminals on its edges. This pan is placed in a bath of sand heated to the required temperature. The other, or positive plate is immersed in the liquid contained in the pan without touching the sides of the latter.

The electrodes employed are generally of platinum, but they are sometimes replaced by carbon rods. For instance, in an apparatus of larger size one of the electrodes is formed by a carbon rod contained in a porous vase, and the other by a series of similar rods connected together and arranged round the sides of a glass vessel external to the vase.

By the action of the current the liberated oxygen, either in its nascent state or as ozone, acts upon the substances which by dehydrogenation or oxidation yield the colouring matters.

The substances on which M. Goppelsrœder makes the electric current act are chiefly salts of aniline, tolindine, and their mixtures, methyline, diphenylamine, and methyldiphenylamine, phenol, and the salts of napthylamine. The principal colouring matters prepared from these are:—

Black aniline, obtained at the negative pole by the electrolysis of an aqueous solution of chlorhydrate, sulphate, or nitrate of aniline acidulated with a little sulphuric acid.

Various aniline blues, obtained at the negative pole by the electrolysis of the chlorhydrates of methamyline, diphenylamine, and methyldiphenylamine.

Hoffmann's violet, obtained at the negative pole by the electrolysis of a solution of rosomiline salt with methylic alcohol added, with a little sulphuric acid, and a small quantity iodioc of potassium.

The results are exceedingly interesting, and promise to found a new industrial application of electricity; but as yet they are little more than experimental, and the question of cost has not yet been determined. It is not known how far the new method will be able to supplant the old chemical way of preparing these dyes, but with the employment of the dynamo-electric current, it may be that the new plan will prove the cheaper. M. Goppelsrœder has hitherto used a battery of sixteen bichromate of potash cells, or an equal number of Bunsen elements. It is curious to remark that different colours can be obtained from the same operation kept up for a longer while. Thus, during the electrolysis of an aqueous solution of pure chlorhydrate of aniline acidulated with a little sulphuric acid, a coat of emeraldine, which is intermediate between aniline and aniline black, is obtained during the first second on the negative plate. At the end of ten minutes a thick coat of emeraldine is obtained, which marks a second phase of the process. In the third phase aniline black of an indigo blue colour and a small quantity of green emeraldine are formed.

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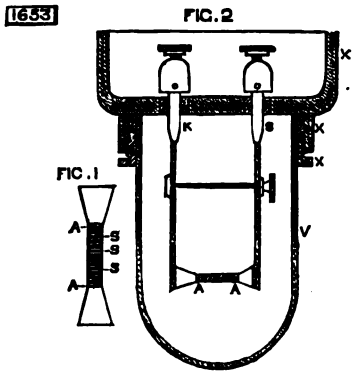
RECENT INVENTIONS.

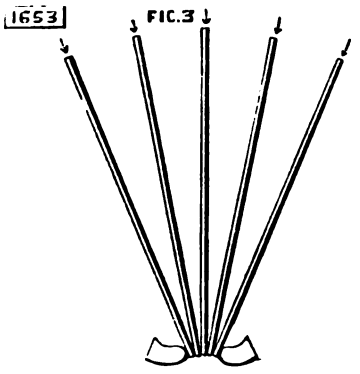
ABSTRACTS OF SPECIFICATIONS.

1653.—IMPROVEMENTS IN ELECTRIC LAMPS, *J. H. Johnson.—14th April*, 1881.—(*A communication from the Société La Force et la Lumière Société Generale d'Electricité.*) 8*d*.

This invention relates to the form of materials used for electric lamps. In one form the carbon



to be rendered incandescent as is shown in Figs. 1 and 2, the conductor A A being made up of



sections S S. Fig. 3 shows another form for use when air is not exhausted.

1676. IMPROVEMENTS IN SECONDARY ELECTRIC OR GALVANIC BATTERIES, *J. H. Johnson.—16th April*, 1881.—(*A communication from C. A. Faure.*) 6*d*.

The patent refers more to the manner of securing the layers of the active substance in the secondary battery than to a new application. The

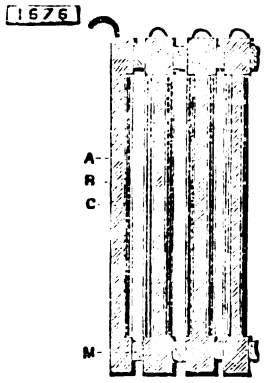
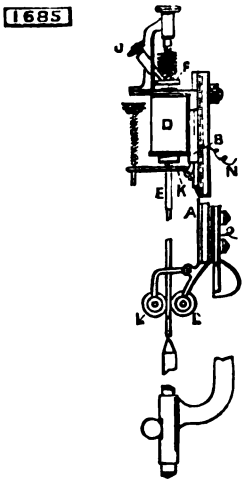


figure shows the form now adopted—A showing the lead plate, B the minium, C the felt; M is a strip of india rubber to make a good joint so as to make a series of cells.

1685. IMPROVEMENTS IN ELECTRIC LAMPS OR REGULATORS, *A. M. Clark.—18th April*, 1881.—(*A communication from J. M. A. Gerard-Lescuyer.*) 8*d*.

This invention relates to several modications in the method of regulating the electric arc, one of which we illustrate. According to this method the current enters at N, and the carbon being separated passes through the solenoid D, and causes the armatures K F to be attracted. The oscillation of F releases the grip of the jaw L, and allows bracket B to descend. As soon as the carbons come in contact the current passes through them, coil D becomes inert, and the armatures are withdrawn by their springs, the



one causing jaw L to again bind against the guide A, and thus arrest the descent of the bracket B, and the other causing the upper carbon to be suddenly separated from the lower one, thereby establishing the arc, the size of which is regulated by screw J. Should the resistance of the arc become too high, the current again traverses coil D and the upper carbon slowly descends. The feeding of the carbons is effected by continuous and insensible vibrations without jerks.

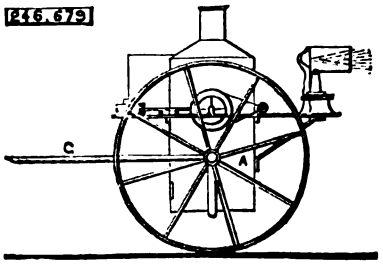
1696. IMPROVEMENTS IN TELEGRAPHY, *S. Pitt. 19th April*, 1881.—(*A communication from Dr. A. Lugo.*) 6*d*.

This is an improvement on patent No. 1,119, dated the 15th March, 1881, and its object is to construct a single cable or compound conductor, through which two or more independent circuits can be established without the disturbances caused by induction. The figure shows the invention as

applied to a telegraphic and telephonic circuit, and requires no description. According to the inventor the currents, transmitted through one conductor of each circuit, will return through the other, and the inductive influence of the currents, passing through the two sets of conductors, will be equal and opposite, thus inductive action will be neutralised.

243,679. LIGHT FOR LIFE-SAVING STATIONS, *Ralph S. Jennings, Baltimore, Md.—Filed May 19th*, 1881.

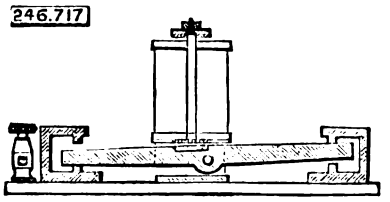
Claim.—(1) In combination with the wheeled vehicle carrying an engine and boiler, as set forth, the dynamo-electric machine, and an electric light pivotted about a horizontal and a vertical axis, as



and for the purpose described. (2) In combination with the wheeled vehicle having tongue or shafts G and boiler A, the dynamo-electric machine and the electric light, mounted, as described, at the rear of the machine, substantially as and for the purpose set forth.

246,717. TELEGRAPH SOUNDER, *Charles C. Burke, New York, N.Y.—Filed April 23rd*, 1881.

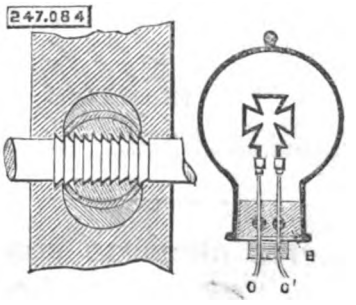
Claim.—A telegraph instrument or sounder, consisting of an inverted impending electro-magnet, in combination with a supporting frame sustaining such magnet over an underlying armature, such armature being so pivotted that an arm will project on each side of such pivot, one arm bearing the usual cross-piece or armature bar, and thereby made heavier than the other, the up movement of the heavier arm of such



armature and the downward movement of its lighter arm being caused by the attractile force of such magnet, and the down return movement or fall of the heavier arm of such armature and the up movement of the lighter arm resulting from the unequal gravity of the arms of such armature, and such arms being but one piece, a duplication of sound being produced by such movement upward and downward from the impact of the arms of such armature with stops, in combination with such armature and electro-magnet.

247,084. INCANDESCENT ELECTRIC LAMP, *Hiram S. Maxim, Brooklyn, Assignor to the United States Electric Lighting Company, New York, N.Y.—Filed April 25th*, 1881.

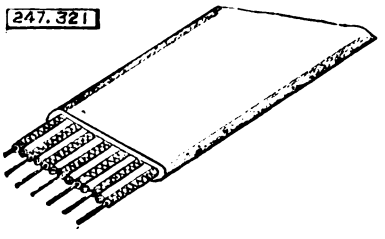
Claim.—(1) The method of sealing wires in glass, which consists in surrounding them pre-



viously to inclosing them in the glass with a mass of metallo-vitreous cement composed of several layers, each one containing a greater proportion of metal in its composition than that of the layer surrounding it, substantially as and for the purpose set forth. (2) In an electric incandescent lamp the combination, with the glass inclosing globe, of a ground stopper B, composed of a body of glass containing the conductors C C1, threaded or grooved as described, and surrounded with a mass of metallo-vitreous cement.

247,321. ELECTRIC CABLE, *Patrick B. Delany, New York, N.Y.—Filed July 16th*, 1881.

Claim.—(1) The method herein described of making lead-enclosed electric cables, the same consisting in arranging longitudinally in a flat lead pipe a series of insulated conducting wires, practically in the same plane, interposing between each conducting wire and the next adjacent conducting wire a bare or naked metallic wire, and compressing the cable so formed until the opposite sides of the naked wires are pressed



against the opposite walls of the pipe, which are caused to partially embrace the conducting wires, substantially as and for the purposes set forth. (2) An electric cable composed of a series of insulated conducting wires arranged in practically the same plane within a flat lead pipe, and separated by complete intervening walls of metal extending between and in contact with, but not integral with nor attached to the opposite walls of the said lead pipe, substantially as described.

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COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Dec. 7.		Business Done Week Ending Dec. 7. Highest.	Lowest.
Anglo-American	52¼,	52¾	53	52¼
Do. Preferred	80½,	81½	81¾	81⅝
Do. Deferred	23,	23½	23½	23
Brazil Submarine	11,	11¼	11¼	11
Cuba	9½,	10	10	10
Do. Preference	16,	17	16¾	16¼
Direct Spanish	4½,	5	5	4¾
Do. Preference	14,	15	14¾	14¼
Direct United States Cable	10¾,	11¼	11¼	10⅞
Eastern Telegraph	10,	10½	10½	10⅜
Do. 6 per Cent. Preference	12½,	13	13	12¾
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	10⅞,	11¼	11¼	11
German Union	10⅛,	10⅞	10¾	10⅛
Globe Telegraph and Trust Company.	6¼,	6½	6 11-16	6½
Do. Preference	12½,	12⅝	12⅝	12⅝
Great Northern	12½,	12⅞	12½	12⅜
Indo-European	27½,	28½	28½	28¼
Mediterranean Extension	2½,	2¾	—	—
Do. Preference	9½,	10	10	9¾
Reuter's	12,	12½	—	—
Submarine	290,	300	—	—
West India and Panama	1⅝,	1¾	1⅞	1 13-16
Do. 1st Preference	7½,	8	7¾	7 11-16
Western Brazilian	7⅛,	7⅜	7⅜	7 5-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1⅜	1 5-16	1⅛
Oriental	¼,	⅜	7-16	⅜
United Telephone	9⅞,	10⅛	—	—

ELECTRIC LIGHT.

Electric Light and Power	1⅛,	1⅜	1⅜	1 5-16
Anglo-American Brush	8½,	9	9¼	8⅞

TRAFFIC RECEIPTS FOR NOVEMBER, 1881.

Companies.	Nov., 1881.	Nov., 1880.	Increase.	Decrease.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	£2,600	£1,960	£340	—
Direct Spanish Telegraph Company	1,810	1,465	345	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,557	29,724	2,833	—
Eastern Telegraph Company	49,829	45,669	4,160	—
Great Northern Telegraph Company	17,120	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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W. T. GLOVER and Co., Insulated Wire Manufacturers, 25, BOOTH-STREET, MANCHESTER. Works: 4 and 5, BRIDGEWATER-STREET, BROUGHTON-ROAD, SALFORD.
Specialities—Specially covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron Wire for Aerial Lines. Fancy covered Copper Wire (Paraffined) for Telephonic and Bell purposes. Cotton covered G.P. Wire for Bell Work. Special Makes of Electric Light Leads for the Brush, Gramme, &c., systems.
All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

RANSOMES, HEAD, & JEFFERIES, Orwell Works, IPSWICH. London Office: No. 9, GRACECHURCH-STREET, E.C.
Specialities—Portable, Vertical, and Stationary Engines, fitted with patent governors, as used in the electric lighting on the Thames Embankment, London, &c.

BRITISH ELECTRIC LIGHT COMPANY (Limited), HEDDON-STREET, REGENT-STREET, LONDON, W.
Gold Medal at the Paris Electrical Exhibition, 1881.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

EDWARD PATERSON, Electrical and Telegraph Engineer, 76, LITTLE BRITAIN, LONDON, E.C., and European Telegraph Works, POWNALL-ROAD, DALSTON.
Telephones and Transmitters, and all Fittings for Central Exchange Systems and Private Lines. Ayrton and Perry's Instruments for Electric Light Measurements. Electric Lighting Apparatus, Cables, &c. House and Mine Signals.

PHILLIPS BROS., Electricians and Electrical Wire Manufacturers, MACINTOSH-LANE, HOMERTON, LONDON.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

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Electric Bells, Fire and Thief Alarms, Water Gauges, Watchmen's Clocks, Telephones and Transmitters. Lines Erected and Maintained. Lightning Conductors. Electric Light Apparatus supplied and fixed. Prize Medal London, 1862; First Prize, Sydney, 1879; Prize Medal, Melbourne, 1880; Prize Medal, Paris, 1881.

BARRAUD and LUNDS, 41, Cornhill, London, E.C.
Inventors, Patentees, and Manufacturers of Synchronised Clocks, Time Balls, Flashing Signals, and all the Apparatus connected with the Determination, Distribution, and Control of Time Signals.

NEWTON'S PATENT LAW and PRACTICE, Price 2s. 6d.
This standard work contains all legal and other information necessary for intending patentees, including Government charges, agency fees, and rules of the Commissioners of Patents.
TRUBNER and Co., Ludgate-hill, and may be obtained at the Office for Patents, 66, Chancery-lane, W.C.

J. A. BERLY'S ELECTRICAL DIRECTORY and ADVERTISER of ENGLAND, 1882.
INTENDING ADVERTISERS in the 1882 EDITION (first issue), should at once apply for particulars, terms, &c., to J. A. BERLY, 16, New Bridge-street, London, E.C.
For Press opinions vide "Times," 18th; "Iron," 18th; "Engineering," 18th; "Electrician," 19th Nov., 1881; "Telegraphic Journal," 1st Dec., 1881, &c.

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CRYSTAL PALACE.

INTERNATIONAL ELECTRIC EXHIBITION.

LIST OF CLASSES.

1. STATIC ELECTRICITY.
2. BATTERIES and ALLIED APPARATUS.
3. MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.
4. CABLES, WIRES, LIGHTNING CONDUCTORS.
5. APPARATUS FOR MEASURING ELECTRICITY.
6. TELEGRAPHS AND SIGNALS.
7. TELEPHONES, MICROPHONES, PHOTOPHONES.
8. ELECTRIC LIGHTING.
9. ELECTRIC MOTOR POWER.
10. ELECTRO-MEDICAL.
11. ELECTRO-CHEMISTRY.
12. MAGNETS, COMPASSES, HOROLOGY, etc.
13. MISCELLANEOUS.
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SPACE HAS ALREADY BEEN ALLOTTED TO THE FOLLOWING EXHIBITORS:—

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Crompton, R. E.
Edison, T. A.
Electric Light and Power Generator Company.
Electric Light Engineering Company.
Electric Lighting Supply Company.
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Elmore W.
Gerard, A.
Graham, D. H.
Gravier and Co.
Hammond and Co.
Hawkes (G.) and Co.
Henley, W. T.
Macdonald, J. Kay Athole.
Mignon et Rouart.
Rowatt and Fyfe.
Scientific Toy Company.
Siemens Brothers and Co.
Siemens Freres.
Sonzée, M. Leon.
Swan Electric Light Company (Limited).
Strode and Co.
Thomas, Evan.
Varley (S. A.) and Co.
Werdermann, R.
White House Mills Company.

Announcements of other allotments will be made from time to time.

THE DIRECT UNITED STATES CABLE COMPANY, LIMITED.

Direct Cable Route for Telegrams

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NEW YORK, BOSTON, SAN FRANCISCO, PHILADELPHIA, CHICAGO, NEW ORLEANS, MONTREAL, TORONTO, QUEBEC,

And all other Telegraph Stations in the United States of America, Canada, West Indies, &c.

REDUCTION OF TARIFF.

RATE TO NEW YORK & CANADA - - - - 1/- PER WORD.

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LONDON ..... 34, THROGMORTON STREET, E.C.
LIVERPOOL... DG, EXCHANGE BUILDINGS.
BOSTON ..... 122, STATE STREET.
NEW YORK... 16, BROAD STREET.

BRANCH STATIONS IN LONDON.

SOUTH SEA HOUSE (adjoining the "Baltic"), THREADNEEDLE STREET, E.C.
EAST INDIA AVENUE, LEADENHALL STREET, E.C.
THE COMMERCIAL SALE ROOMS, MINCING LANE, E.C.
52, OLD BROAD STREET, E.C.

BRANCH STATION IN NEW YORK: 444, BROOME STREET.

To save time, the Public in **LONDON, LIVERPOOL, BOSTON** and **NEW YORK**, are recommended to hand in their Telegrams at the Company's Stations as above, where receipts are given for the amounts charged.

Telegrams handed in at Postal Telegraph Offices, must be marked "Via DIRECT CABLE." This instruction is signalled free of charge.

The Name of the Place from which Messages originate is transmitted Free of Charge.

The Direct transmission of Messages between London, Liverpool, Boston, and New York, and their delivery and receipt in these Cities, is entirely under the independent control of this Company.

General Offices, 52, Old Broad Street, London, E.C. J. W. FULLER, *Secretary and Traffic Manager.*

Just published, Crown 8vo., cloth, 12s. 6d.

A HANDBOOK of ELECTRICAL TESTING. By H. R. KEMPE, Member of the Society of Telegraph Engineers, Assoc. Mem. Inst. C.E. Second Edition, Revised and Enlarged.

London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street.

HARBOROW & CO.,

ELECTRIC LIGHT ENGINEERS

AND

TELEGRAPH INSTRUMENT MANUFACTURERS,

4, CIRCUS STREET, LONDON, W.

DUNCAN WALLET & CO.,

BONDED STORE AND PROVISION MERCHANTS,

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Special Arrangements made for Supply of Goods to Telegraph Stations.

D. W. & Co. have supplied Provisions to the Stations of the Eastern and South African Telegraph Companies, and are prepared to execute orders on specially favourable terms at shortest notice.

INSULATED COPPER WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handled Cord, Silk Cord for Electric Bells, &c.—J. and W. RICKARD, Insulated Wire Manufacturers, Ashbourne-road Mills, Derby

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 23th March, 1872, under the Companies Acts of 1832 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of receivers by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their houses for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS,

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

THE SCHOOL OF SUBMARINE TELEGRAPHY & OF TELEPHONY.

ESTABLISHED IN 1868.

4, GEORGE STREET, HANOVER SQUARE, LONDON, W.

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of the various systems of working in general use, the following subjects:—

MATHEMATICS, MECHANICS, and CHEMISTRY, In relation to Telegraphy.

SIGNALLING and TESTING INSTRUMENTS.

ENGINEERING FORMULÆ and their Application in Practice.

ELECTRO-STATICS.

ELECTRO-DYNAMICS.

MAGNETISM.

METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction.

TESTING FOR and LOCALISING FAULTS, &c., &c., &c.

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A Course of Instruction in the Fitting up, working, and Testing of TELEPHONE CIRCUITS has now been added to, and embodied in, the ordinary curriculum, including all the forms of TELEPHONES, the various switch board arrangements and EXCHANGE SYSTEMS in general use.

Further information can be obtained on application to the SECRETARY.

NEWALL'S PATENT LIGHTNING CONDUCTORS.

Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

NEWALL & CO.'S PATENT COPPER-ROPE LIGHTNING CONDUCTOR,

As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public. It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

SOLE PATENTEES OF UNTWISTED WIRE ROPE.

Manufacturers of Iron and Steel Ropes for Colliery and Railway purposes. Rigging Ropes, Guide Ropes, &c.

Gilt and Silver Cord for Hanging Pictures. Iron, Steel, and Copper Cord for Clock and Sash Lines, &c.

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LIVERPOOL—36, Waterloo Road. GLASGOW—68, Anderston Quay. Manufactory—GATESHEAD-ON-TYNE.

BOROUGH OF ROYAL LEAMINGTON SPA.
ELECTRIC LIGHTING.

The Corporation of the Borough of Leamington invite TENDERS for LIGHTING the PARADE with ELECTRIC LIGHTS.

The specification can be seen, and all particulars obtained, upon application to the Borough Engineer, E. M. RICHARDS, Esq., C.E., at the Town Hall, on and after WEDNESDAY, the 23rd Nov.

Sealed tenders, addressed to the Mayor and Corporation, and endorsed "Tender for Electric Lighting," to be delivered at my Office not later than Ten a.m., on MONDAY, the 12th day of December next.

The Corporation do not bind themselves to accept the lowest or any Tender.

H. CONSETT PASSMAN, Town Clerk.

Town Hall, Leamington, November 15th, 1881.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited).—The Directors beg to announce that increase of the Company's business has made it necessary that they should APPOINT a MANAGER, and that they have secured the services of Professor GEORGE FORBES, M.A., F.R.S.E., in that capacity. It is requested that in future all communications relating to the Company's business may be addressed to him.

WANTED, a GENERAL MANAGER for an Electric Lighting Company in a large city. To a gentleman capable of developing and conducting a large business, and having sufficient knowledge of electricity to enable him to properly supervise the working of the staff necessary to the business, a liberal salary would be given.—Apply by letter, stating terms expected and previous occupations, to "N, W.," care W. H. SMITH and SON, 186, Strand, London.

ESTABLISHED 1851.

BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane

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SLIP

TELEGRAMS FOR TURKEY.—The cable between Salonica and Tenedos is now repaired.

TELEGRAPH CABLES REPAIRED. —The cables between Bushire and Jask are now repaired.

TELEGRAMS FOR SOUTH AMERICA.—The cable between Pernambuco and Bahia is now repaired.

THE TELEGRAPHS IN QUEENSLAND.—Bush fires have been interfering with telegraphic communication north of Bowen, in this colony.

THE TRANSVAAL.—It is reported from this country that our Government has offered to give the telegraph line to the local Government.

THE ELECTRIC LIGHT AT NICE.—The 32 Brush lamps which have been running at Nice for some little time are to be increased to 48.

ELECTRICITY V. SMOKE.—Dr. O. J. Lodge was announced to deliver a lecture on the above subject last Thursday night at the London Institution.

CANADIAN TELEGRAPHS.—Dr. P. Fortin, of the Local Legislature, is said to be preparing a report on the working of the Gulf telegraph system.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The offices of this company have been removed to Dashwood House, 9, New Broad-street, E.C.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ended December 2 and 9 were £3,581 and £3,656 respectively.

QUADRUPLEX IN CANADA.—We hear that a new quadruplex instrument (the first ever used in Canada) has been introduced between Montreal and Toronto.

EASTERN EXTENSION, &C., COMPANY.—This company has declared an interim dividend for the quarter ending the 30th of September last, of 2s. 6d. per share, or at the rate of 5 per cent. per annum, tax free, and payable January 14.

THE TELEPHONE IN SYDNEY.—It is reported that there are now a hundred telephones in operation in Sydney constructed and maintained by the Telegraphic Department.

ELECTRIC LIGHT AT STRASBOURG.—It is proposed to form a company at Strasbourg to supply electric light to the workshops and factories of that town, as well as others in Alsace.

ELECTRIC LIGHT AND FOG.—During the intense darkness which wrapped the metropolis on Friday week the electric lights in the City did good service, being alight from an early hour in the day.

ROYAL SOCIETY.—The following paper was down for reading at this society on Thursday last, viz., on "Some Effects of Transmitting Electric Currents through Magnetised Electrolytes," by G. Gore, F.R.S.

THE BRUSH LIGHT IN PARIS.—Fifty-four Brush lamps have for some time past been in use in the sorting department at the Paris Post Office, and this number is, we believe, to be increased by 16.

THE BRUSH LIGHT IN AMERICA.—The Brush Electric Light Company, of Louisville, Kentucky, filed articles of association recently with a capital stock of 150,000 dollars. All the capital has been subscribed.

BRIGHTON HEALTH CONGRESS.—The grounds of the Royal Pavilion and the Dome in which the Exhibition of Domestic and Sanitary Appliances and the Health Congress are now being held are lighted by electricity.

GREAT NORTHERN TELEGRAPH COMPANY.—Erratum. The traffic receipts of this company for the period from 1st January to 30th November amounted to £218,000, and not £222,000, as stated in our last issue.

ELECTIC LIGHT FOR CAMBERWELL.—The vestry of this parish have directed their general purposes committee to consider the question of improved lighting for the streets of their district by gas, electricity, or otherwise.

CABLE LAYING IN CANADA.—News from the Dominion says that the laying of the cable across the Saguenay River is complete. Its construction is to some extent experimental, the cable being covered with phosphor bronze wire.

THE NEW ATLANTIC CABLES.—It is reported that a small section of the American Telegraph and Cable Company's second cable was successfully laid at Penzance the other day. The section lies between Penzance and Whitesand Bay, near the Land's End.

THE TELEPHONE IN PORTUGAL.—The Edison Gower-Bell Telephone Company of Europe have received a telegram from their agent at Lisbon stating that a concession has been granted to that company for the exclusive right of working telephones in Portugal.

TELEGRAPH STORES WANTED.—Tenders are being invited for the supply of the stores required by the Swiss Telegraph Department during 1882. Particulars may be obtained from Dem Telegraphen Direktion, Bern, where tenders will be received up to the 20th December.

TELEPHONES AND RAILWAY ACCIDENTS.—The recent lamentable accident on the North London Railway at Canonbury suggests the use of a telephone in each signal box as a supplementary means of communication in addition to the ordinary telegraph instruments.

ELECTRIC LIGHT IN ADELAIDE.—The *Melbourne Age* of the 20th October says that an exhibition of the electric light, with a view to testing its fitness for street illumination, took place from the tower of the post office on the previous night at Adelaide, South Australia, and was very successful.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ending the 2nd and 9th December, 1881, were respectively £2,127 and £2,296, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

NEW COMPANY IN BELGIUM.—The Compagnie Belge et Hollandaise d'Electricité has been registered at Brussels, to supply light, power, &c., in Belgium and Holland. Its capital is five million francs, in 20,000 shares of 250 francs each. It is possessed of the Belgian patents of Faure, Julien, and Regnier.

ELECTRIC LIGHT IN TRAINS IN FRANCE.—The French are close on our heels with the introduction of the electric light into trains. We hear that a train running between Paris and Soissons on the 7th of this month was lit up by the electric light, this being the first experiment of the kind in France.

THE DIRECTOR OF HUNGARIAN TELEGRAPHS.—It is stated that Herr Koller, of Granzow, has been appointed Director-General of Hungarian Telegraphs in place of the late Herr Takacs, whose death we noticed some time since. Herr Koller was present at the Telegraph Conferences in St. Petersburg and London.

ELECTRIC LIGHT AT HAVRE.—It has been found that the standards supporting the electric lights in the harbour at Havre are not sufficiently tall to obtain the full benefit to be derived from the light so as to enable ships to be worked at

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night. The standards are, therefore, to be made twice as high again as they are now.

THE ELECTRIC LIGHT IN CHURCH.—Dr. Parker, of the City Temple, who will have the Edison lamps to illumine his church before many days are over, will not enjoy the proud position of being the only preacher by electric light very long. We hear that the Rev. Dr. Cosens, Vicar of Dudley, contemplates the use of the electric light in the parish church there.

ITALIAN TELEGRAPHS.—According to a recently-published report the total length of the telegraphs in Italy at the end of 1880 was 26,114 kilometres, showing an increase of 581 kilometres in 12 months. The total length of wires was 85,733 kilometres, against 84,101 kilometres. The number of telegrams for the year was 6,763,200, or 628,278 more than in 1879.

ELECTRIC LIGHT IN THE FRENCH NAVY.—It is said that the French Government have determined to send a technical commission to Toulon to determine upon the advantages accruing from the use of the electric light in war vessels. The application of the light to the arsenals and dockyards in which ships are in course of construction is also to be considered by the commission.

THE LONTIN SYSTEM.—*L'Electricité* says that the Paris, Lyons, and Mediterranean Railway Company has extended its system of electric lighting by means of the Lontin lamp recently. The number of lamps now in use at its Paris station is 54, which are said to work very well. The Marseilles Station of the company already possesses eighteen of these lights, and eighteen are to be shortly erected.

ELECTRIC LIGHTING AT THE MANSION HOUSE.—Mr. Crompton is getting on with his arrangements for lighting the Egyptian Hall and Saloon in the Mansion House with a combination of his arc and the Swan incandescent lamps, and it is probable that in another week or so the lighting will be begun. The fittings of the chandeliers and lamps have been specially designed for the occasion, and will all be stamped with the City Arms.

THE TELEPHONE IN MADRAS.—Madras has stolen a march upon Bombay and Calcutta in the matter of the telephone at all events. Messrs Arbuthnot, the local agents of the Oriental Telephone Company, recently had a field day, having connected the Band-stand and the Club with the Central Exchange at their offices. The inter-communication was perfect, and the experiments gave great satisfaction to the Madrasees.—*Homeward Mail.*

NEW ATLANTIC CABLE COMPANIES.—The *Standard* of a recent date stated that the repair of the Gould cable is now completed, and that fresh competition in American and Indian telegraphy may be looked for from a new company to be launched next month. With all due respect to our usually well-informed contemporary we beg to doubt both pieces of information. We know the first to be incorrect, and the second we do not believe.

LIBRARY OF THE SOCIETY OF TELEGRAPH ENGINEERS.—The energetic librarian of this Society has a goodly list of accessions to show, which have been obtained during the past year. He has also prepared an Index to the *Journal* of the Society, and to the Specifications of Patents, which, writing as we necessarily do before the annual meeting, we trust will be welcomed by the Council and Members as they deserve. Such an Index is of great importance and value.

INFRINGING PATENT RIGHTS IN AMERICA.—It is stated that at a recent meeting of representatives of the Brush, United States, American, Fuller, Weston and Jablochkoff electric companies in New York it was decided to enforce to the fullest extent their patent rights against infringing companies. A committee was appointed to act with the Board of Fire Underwriters in making an exhaustive investigation of the alleged danger of fire from the use of the electric light.

TELEPHONE LINES IN BELGIUM.—In the summer of this year, when on a visit to Antwerp and other towns of Belgium, we were struck by the vast network of telephone wires with which these towns, particularly Antwerp, is overrun, and remarked upon it in a note at the time. We now hear that the matter is being brought before the Belgian Parliament, and the question of underground or overhead wires is being debated. It is proposed to lay all wires at Brussels underground.

INDIAN TELEGRAPH TARIFFS.—The tariff for inland telegraph messages, it is stated, will, probably, undergo further alterations on January 1st next, the ordinary rate being fixed at one rupee for eight words or under, and two annas for each word in excess, while messages not required to be delivered before the next morning will be carried at half this charge. Not many months ago the rate was reduced to one rupee for the first six words and two annas for each word in excess. (*Electrician*, Vol. VII., p. 163.)

PROTECTION OF SUBMARINE CABLES.—We are glad to see that this question has been taken up by the Society of Telegraph Engineers and of Electricians. At a recent council meeting of the society it was resolved that, in view of the great importance of the question, the society should urge upon the Government the extreme desirability of international agreement and subsequent legislation for the protection of submarine cables from careless and wilful damage. A committee was appointed to take the necessary steps.

KING'S COLLEGE.—An interesting lecture on "Explosives" was delivered by Mr. W. P. Bloxam on Wednesday evening in the Theatre of King's College, Professor W. G. Adams in the chair. The use of a galvanic current in igniting charges was illustrated, with due precautions for the safety of the audience. The experiments with nitro-glycerine were such as would ensure the lecturer the careful attention of the Russian or Irish police. This is the promising first appearance of a gentleman whose name will be recognised as *clarum et venerabile* in the chemical world.

ELECTRIC LIGHTING FOR RAILWAY STATIONS.—Our contemporary, *L'Industrie Belge*, announces that the Public Works Department of that kingdom are about to light several railway stations by means of electricity. The difference which exists in the prices of gas at the various places will be taken as a guide in choosing the stations in which the electric light is to be introduced. The terminus which is being constructed at Bruges, where gas is very dear, will be one of the first to be lighted by the new medium. It is proposed to invite tenders for the work, but we believe the matter has not been finally settled.

CHELTENHAM.—Messrs. Woodhouse and Rawson have successfully installed the Brush electric light system in the Winter Gardens at Cheltenham. During the past week a lawn tennis tournament has been played, the play commencing at half-past four each afternoon, and has resulted in capital sport. The same firm of engineers has also carried out a somewhat novel experiment at the residence of Sir A. Ramsay, the light from two Brush lamps outside the house being so arranged as to light up certain rooms in the interior The light was softened by being shaded from the inside by pink muslin curtains, causing the reception rooms and everything in them to appear to great advantage.

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ELECTRICITY AND BEE CULTURE.—It is stated that some German experimentalists have been successful in their attempts to utilise electricity as a means for hiving swarms of bees, by stupifying them. A successful attempt was made upon bees that had gathered upon trees, the insects falling upon the ground in a kind of trance, which admitted of their being safely handled. A further experiment was made of introducing the ends of two connecting wires into a fully occupied honeycomb, and turning on the current; by this means the bees were rendered inactive for about 30 minutes, while no bad results appeared to follow their awakening. When are we to have electric mouse and rat traps, to say nothing of fly catchers?

MEAN TIME IN FRANCE.—The French are becoming aware of the importance of knowing the correct time, particularly in seaport towns, in order that ships' chronometers may be set before starting on a voyage. Rouen has hitherto been almost alone in the privilege of having the time signalled to it from Paris by telegraph. Now, however, Havre must be ranked with Rouen in this respect. An astronomical pendulum has been placed in the Salle des Pas Perdus of the Bourse at Havre, which indicates Paris mean time, and is corrected by electric signal from the Observatory at Paris once a week. No doubt this will sound odd in the ears of Englishmen, accustomed as they are to regulate their watches, &c., by clocks which are set right by Greenwich time at one o'clock every day.

CRYSTAL PALACE INTERNATIONAL ELECTRICAL EXHIBITION.—All the available space has now been allotted, and we believe several applications have had to be refused. It is probable that a portion of the electric lights may be in running order by Christmas, but the greater part of the exhibition will not be ready until January. One feature which was absent from Paris will be the exhibits of the War Department, which, remembering the good service done by our field telegraph trains in the campaigns in Afghanistan and the Transvaal, will, no doubt, prove interesting. It is stated that in addition to the Siemens electrical railway (already running in the Palace grounds) an electrical tramway will be constructed on one of the terraces, the car of which will be run by the aid of Faure batteries.

ELECTRIC LIGHTING EXTRAORDINARY.—At a recent meeting of the Lambeth Vestry one gentleman said that "the area of Lambeth was 4,015 acres, and that lighting towers might be erected that would give light over an area of half a mile. Eight of these towers would light the parish, at a cost of about one guinea per night per tower, in such a way that a newspaper might be read at a distance from the light of half a mile." We are inclined to think that this gentleman's plan reads better on paper than it would work in practice. It is almost needless to say that the Vestry did not agree with his views, and consequently such a mode of lighting is not likely to be tried. We should not be surprised, however, to hear that the electric light had been introduced into Lambeth in a less ambitious way.

A NOVEL ACCIDENT.—The Paris correspondent of the *Daily News*, in a recent issue of that paper, says:—"An attendant at the telephone station in the Rue de Bac received a severe shock yesterday morning. Having opened communication with another station, he was awaiting a reply, when a volume of flame and smoke issued from the tube containing the wires. The fire quickly spread to the walls of the room, and was not extinguished until considerable damage had been done and several sets of apparatus destroyed. On the matter being investigated it was found that a workman in a sewer under the Boulevard St. Germain had accidentally burst open a gas pipe, and so set fire to the inflammable covering of the telephone wires running alongside. The flames spread rapidly, and thus reached the office in the Rue de Bac."

CONDUCTORS FOR TELEPHONES.—Mr. Edwin Truman, of 23, Old Burlington-street, W., has been engaged on the manufacture of a good telephone conductor, composed of two or more wires, his object being to obviate induction. Mr. Truman constructs his conductor on the metallic circuit system of two wires wound in a spiral form, placed in one covering, the wires being kept equi-distantly apart, and insulated from one another. He can, however, make his conductors so that they shall contain as many as six or even more wires, all of which shall be equi-distant from one another, and insulated. One of the conductors, a mile long, containing six wires, said to be insulated from one another by about 6,000,000,000 of units, and from the water in which the conductor was laid by as many as 13,470,000,000 of units per statute mile, was recently tested at Mr. Truman's works at Vauxhall by some of the Post Office officials. The core of these conductors is made of solid gutta percha.

THE TELEPHONE IN MELBOURNE.—With reference to the recent attempt to establish telephonic communication between Sydney and Melbourne, mentioned in *The Electrician*, Vol. VIII., p. 401., Mr. J. E. Edwards, of 133, Little Collins-street East, Melbourne, writes to *The Argus* as follows:—"I notice in to-day's *Argus* an account of a telephone experiment between Melbourne, Albury, and Sydney, in which it is stated that only very faint sounds of the voice were heard between the extreme ends of the line; but perfectly audible speech was transmitted between Melbourne and Albury, thus establishing the important fact that even on telegraph wires, not specially constructed for the operation of telephones, oral messages can be sent 200 miles. As the above statement is rather misleading to the public, and makes out to be the first successful experiment ever made in the colony at such a distance, I beg to correct it, and state that the important fact was established two years ago, when I succeeded in obtaining as good a result on the same lines."

TELEPHONE EXCHANGE WIRES IN SHEFFIELD.—The Corporation of Sheffield desiring the opinion of a professional expert as to the security of the telephone exchange and other wires erected in that town, have requested Mr. John Walsh, late divisional engineer of the postal telegraphs, to make an examination and submit a report. We have had so many complaints as to the careless erection of overhead wires by the telephone companies that we are glad to record the following extract from Mr. Walsh's report:—"Messrs. Tasker, Sons, and Co.'s telephone exchange and private wires are well and substantially erected, and I am pleased to observe that the wires are, where possible, placed on strong poles, and not attached to buildings. The telephone lines of Messrs. Tasker withstood the severe storms of October and November without injury, and there could be no better test of their strength than this. Their manager (Mr. Johnson) is on efficient telegraph engineer, and, no doubt, will continue to keep the telephone wires in a good state of repair and condition."

CITY AND GUILDS INSTITUTE.—The distribution of prizes and certificates to the successful students in the various schools connected with this institute took place on Friday evening, the 9th inst., at the Drapers' Hall, Throgmorton-street. Mr. W. Chapman, Master of the Drapers' Company, presided, and amongst those present were Sir F. Bramwell, vice-president; Mr. P. Magnus, Director of the Institute; Mr. Samuelson, M.P., Chairman of the Royal Commission

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on Technical Education; Sir John Bennett, and Professors Armstrong and Ayrton. The chairman, in reviewing the past history of the institute, said that in 1879 there were 202 candidates, who were examined on seven subjects. Of these 151 passed. In 1880 the number increased to 816, who were examined in 24 subjects, and 515 passed. In 1881 the number was 1,563,who were examined on 28 subjects, of whom 895 passed. Within the last few days the lists for 1882 had been closed, and they contained 3,229 candidates, resident in 105 towns. The prizes and certificates to be distributed on this occasion were the result of examinations, which took place in May, in 92 towns—63 in England, 5 in Wales, 9 in Scotland, and 15 in Ireland, and the system was carried on by registered teachers, of whom there were now 211. Sir F. Bramwell then distributed the prizes and certificates to the successful students.

Ball Lightning.—The following is taken from the *Evening Citizen* of Glasgow for the 25th Nov. :—"Those on board the Campbelton steamer "Kinloch" (Captain Kerr), which left Greenock on its usual run about half-past eleven o'clock on Tuesday morning after the storm had raged during the night, had a somewhat extraordinary experience while passing down the Firth. The vessel was enveloped in a dense shower of hail, and for some time it was awfully dark, and occasionally the vessel was lit up by vivid flashes of lightning. About noon while opposite the Clock Lighthouse, and not far from the shore, the captain observed immediately over the ship what appeared to be a series of clear balls of lightning, each about a foot in length, and resembling a chain, except that they were disconnected. This phenomenon was quickly succeeded by an explosion in the funnel of the steamer, and several balls of fire upon the bridge running about, and then bounding of into the water. A fireman rushed on deck to see what had happened, as the engine room was filled with smoke, and a choking sensation was experienced below. The explanation appears to be that a portion of the lightning had passed down the funnel until its force was spent by the fire, and the sudden recovery of the draught of the funnel afterwards accounted for the loud report that was heard." A somewhat similar case of ball lightning was given in *The Electrician*, Vol. VII., p. 227.

A Visit to the Paris Exhibition.—A report has been received by the Corporation of Manchester from a sub-committee deputed by them to visit the Electrical Exhibition at Paris and report on the exhibits. The committee were evidently very much impressed by what they saw, though as they do not seem to have included an electrician amongst their number, their report is rather a general one. Electric lighting forms the burden of the report, as might be expected, though Faure's battery takes a prominent position also. We extract the following as being the opinion of ordinary business men on electric lighting. The report says :—"The fact that the powerful companies formed for the manufacture and supply of the various apparatus are at present unable to meet the demand upon them is evidence that electric lighting is rapidly growing in public favour. There is no doubt ample margin in the prices at present charged for some of the lamps and apparatus to allow of a considerable reduction which would still leave a substantial profit. The Edison lamp, for instance, which is sold at 4s., is said to cost 1s. 5½d., while the Swan lamp, a very similar one in construction, was until very recently sold at 25s., and it is clear that at the reduced price of 12s. 6d. there still remains an enormous profit for the inventor. It may be noted, as indicating the position now being assumed by electricity, that one of the leading exhibitors expressed his willingness to undertake its supply at a price not exceeding the price at present charged for gas, the illuminating power to be quite equal to that of gas, and he claimed that he would at the same time realise a large profit."

The Society of Telegraph Engineers and of Electricians.—Our readers who are members of this society will be annoyed to find that the arrangements for electing its officers for the ensuing year are precisely the same as those which were strongly protested against some two or three years ago. To begin with, the balloting papers have reached the members not a day earlier, in some cases later, than the ordinary notice of meetings. No time, therefore, was afforded to members and associates to suggest nominations, or to agree upon any common choice from the list furnished by the council, even if there were any choice. As, however, the council seems to have been unanimous in nominating only the exact number of persons required, perhaps it assumed that the rank and file would be equally unanimous. We hope they are. At the same time, it must be apparent to everybody not of the council, that its ideas of election are somewhat of the hollowest ; and that to print Rule 22 upon the balloting paper is an unwarrantable waste of printers' ink and stationery. According to that Rule, "each member shall be at liberty to make a selection from the list." As interpreted by the ruling body, this liberty apparently consists in being free to make Hobson's choice. There is a sad lack of humour, we fear, at the head of affairs just now, otherwise the absurdity of the whole business would have been perceived. If any one of the council ever become a candidate for parliamentary honours, and is not opposed—which, of course, nobody would dream of doing—we can only hope that he may be put to the expense and trouble of a "ballot" all the same. He will then, perhaps, see the joke.

Electric Lighting.—Fatal Accident.—A fatal accident occurred at Hatfield House, the residence of the Marquis of Salisbury, to a labourer named William Dimmock, 22 years of age, in consequence of coming in contact with the wires conveying the electric current for lighting the mansion. Hatfield House is lighted with 117 lights on the Brush system, worked by an engine of 16-horse power, placed in the sawmills some distance from the house; two electric wires and a telephone wire connect the sawmills with the house ; for some distance they are carried on poles, but to save the unsightly appearance of the poles near the house, the wires are run along the garden wall, three feet from the ground, and for some distance are not protected. The deceased was at work in the garden, assisting to lay a telephone wire, and was sent to ease the wire at the corner of the brickwork to prevent it getting cut. While he was absent the linesman heard the wires shake, and on looking round saw the deceased lying on his back, and on going up to him found he was dead. The machine was at work at the time, some of the Brush Company's men being down from London repairing it, and it is supposed that the deceased slipped, caught hold of the electric wires to save himself, and was immediately killed by the shock. The medical evidence showed that death arose from shock to the system, causing paralysis of the heart. At the inquest the jury returned a verdict that the deceased died through touching the electric wire, and appended a recommendation that there should be a stated time for working the current, and that notice should be given of it to all persons working near the wires. It was stated that, to avoid similar accidents in future, the wires would all be conveyed either underground or on poles out of reach.

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THE ELECTRICAL EXHIBITION AT PARIS.

Messrs. Clark, Muirhead, and Co., among the large collection of apparatus exhibited, had many specimens of the manufacture of the Western Electric Manufacturing Company of Chicago and New York, for which company they are the European agents. We have often given credit to the Americans for their early adoption of the sounder, but our faith in their foresight is somewhat rudely shaken when we find that the adoption of the sounder was compulsory. It is another case of necessity being the mother of invention. Its adoption was from no conclusive evidence of its superiority, but from inherent badness of the original Morse system. Our friend Mr. David Brooks, of Philadelphia, in his report of the Vienna International Exhibition, 1873, says:—The original apparatus (the Morse register) has long been felt to be defective in the following particulars:—

i. It requires a considerable weight to move the train.

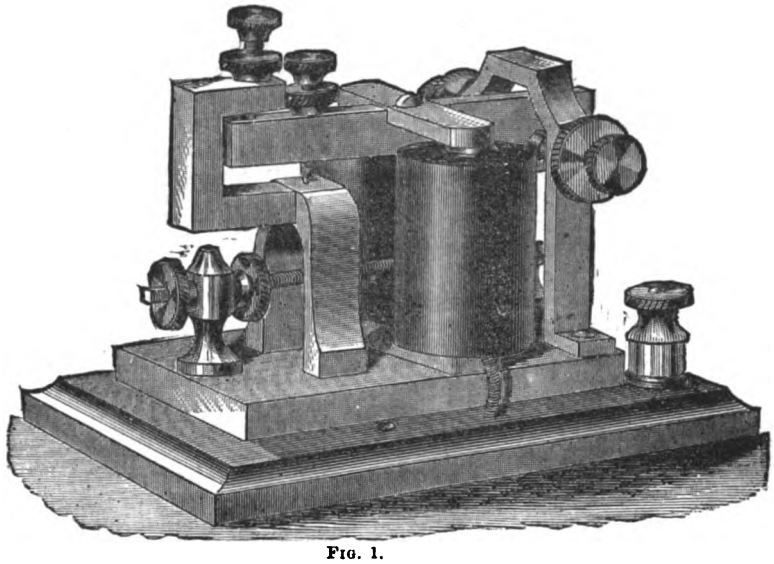

FIG. 1.

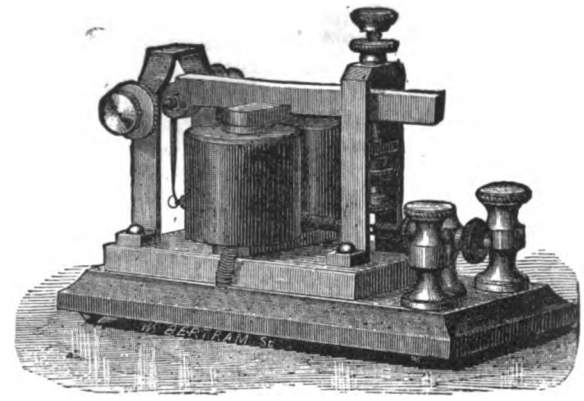

FIG. 2.

ii. Inequalities in the thickness of the paper, or other causes, are apt to occasion the paper to stop between the rollers, thus producing imperfect characters, or omitting them altogether.

iii. The characters of the Morse are only legible when held between the person and the light, or in such a position as to bring a shadow of the impression in view to the eye.

iv. The character is very easily erased or obliterated, and hence poorly adapted for preservation as a record or a proof of correct or incorrect transmission.

Mr. Brooks goes on to state that these defects are obviated in the ink-writer as used in Europe, then continues:—

"The defects of the American Morse register led to its gradual disuse, and the adoption of the sounder. The register made sufficient tick to be audible, and the operator while using the register soon became so familiar with the ticking as to be able to read the despatches by ear. Within two or three years after the telegraph was fairly in operation in this country there were operators who read entirely by sound, but the sound was that of the ordinary register. It was not until some years afterwards—about the year 1858—that sounders were made, instruments constructed upon the same principle as the register, with the clockwork and paper omitted. The advantage afforded by the ability to read by sound resides in the fact that the operator is not obliged to direct his eye from his pen while copying the despatches, a case precisely analogous to that of a person taking a copy with the words read or spoken to him, instead of being obliged to read them for himself. If the operator is a rapid penman he can even direct his eye from his pen at times, and keep pace with the writing of the characters as they are made by the transmitting operator at the other terminal. This is the more easily done where the characters are in ink, as made by the Morse ink-writer. In Europe, indeed, operators frequently read by sound, but the copy as printed by the ink-

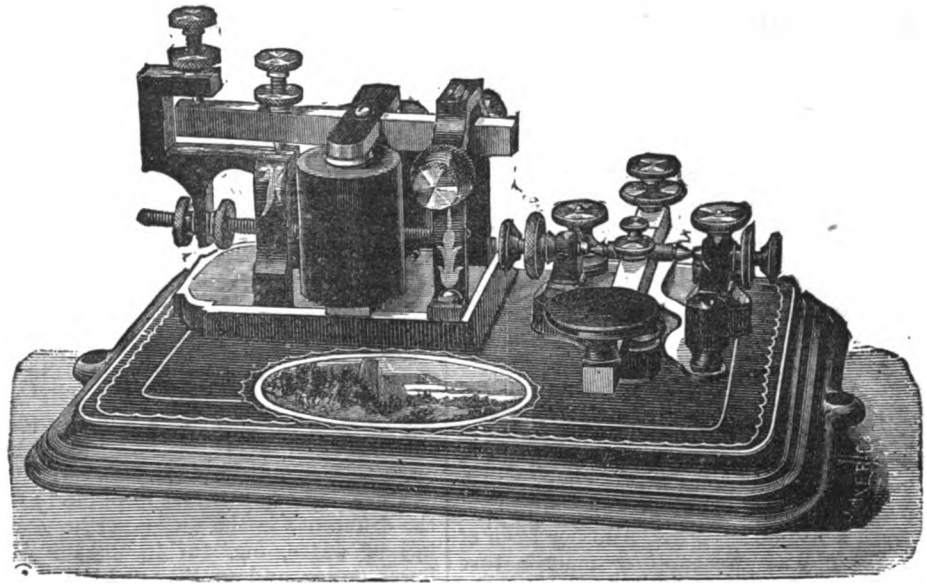

FIG. 3.

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writer is preserved for reasons before stated. As the magnetic force required to work the pen of the ink-writer is small compared with that required to emboss, it permits of the ink writer being worked in the direct circuit of the line, and to that end the core of the magnet is wound with fine wire, giving the helices a resistance of 500 units, or less, according to the length and resistance of the line. This arrangement dispenses with the local battery. The chief and obvious advantage of the ink-writer over the American sounder consists in the ease of learning to read the printed characters, as compared with the difficulty of learning to read by sound. The printed characters are legible to a beginner as soon as the alphabet is known, a task which a person of average intelligence may accomplish in a day, while to learn to read by the sounder necessitates a familiarity with the tick which cannot be acquired save by the practice of a year. Good sound-operators are expensive—that is, they command salaries twice as high as operators who read the printed characters equally well and are otherwise equally qualified. Another objection may with good cause be urged against the sounder, as employed in this country. It is usually placed in public places, such as hotels, commercial exchanges, railway stations, and the like, where the click can best be heard by the public, and attract attention. This public situation places it within the power of evil-disposed persons to make improper use of information which they may readily acquire. Operators, for

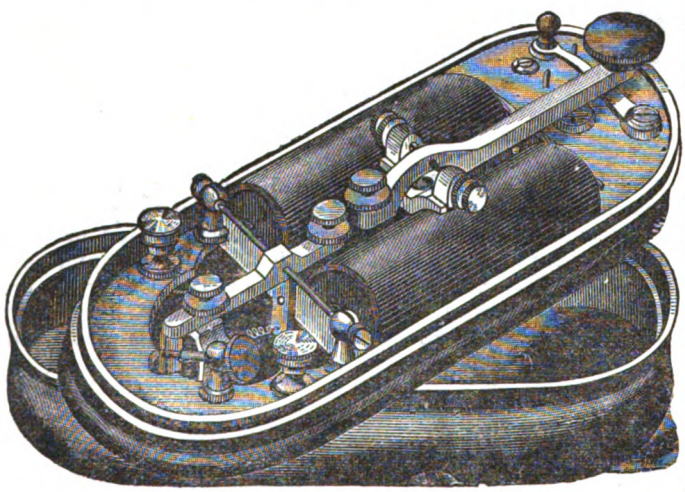

Fig. 4.

example, who are out of employ, or who are in the employ of rival companies, or who have left the service, can, without difficulty, from the sound of the instrument, read the contents of despatches and make use of such information to serve their own purposes. There is every reason to believe that this is often systematically practised. The substitution of ink-writers for the sounders would obviously overcome this grave objection."

Messrs. Clark and Muirhead show the sounder illustrated by Fig 1, which, says Mr. Prescott, is much used on railway lines, or in places where external noises are liable to interfere with the sound of the instrument. It has a heavy armature lever, and an arch or bridge is provided upon which the downward stroke of the armature takes effect. The base piece is arranged to form a sounding box. Another form of sounder is shown in Fig. 2, and the company manufacture sounders of other patterns, some specially designed to be used under certain conditions, others designed for use under different conditions. Fig. 3, for instance, shows a combined key and sounder, as fitted upon a large number of private lines, while Fig. 4 represents a compact and convenient form of main line sounder with a key attached, forming a complete apparatus. The whole arrangement is packed in a small case, and can be carried in the pocket. One essential common to all sounders is that the instrument should be screwed tightly to the table, so that the acoustic vibrations should be intensified by the latter, which then acts as a sounding board.

CORRESPONDENCE.

THE EFFICIENCY OF ELECTRIC LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Professors Ayrton and Perry have in their paper, "The Efficiency of Electric Lamps," made comparisons of the different lamps exhibited at the Paris Exhibition which appear to me to be misleading and erroneous.

It is obviously a mistake to compare electric arc lamps, or semi-incandescent lamps, with incandescent lamps in vacua, and to test them all in the same horizontal position, inasmuch as the incandescent lamps practically give the same light in any position, whilst only the minimum light is given by "arc lamps" (such as those tested) and semi-incandescent lamps in the horizontal position.

I was present on two occasions whilst the professors were testing my lamps, and the results varied as much as one hundred per cent. They gave me at the time, red glass 100 candles, green 140, and again red 140, and green 180 and 200 candle-power, and all with exactly the same light which they now give as 70 candle-power! Different observers gave altogether different powers of one and the same light. The extraordinary difference of candle-power between the "Pilsen arc Lamp" and the "Brush Arc Lamp," whilst the electrical conditions appear identical, calls for some explanation, and I hope the Professors will favour us with further tests, and those explanations, and make them equally as public as their recent report.

Tests which are so scanty and incomplete (except in the case of the Maxim lamp), and which do not give the number of lamps in circuit, the maximum and minimum candle-power at all angles, the volume of light in some unit of illuminated area as well as the intensity, the colour of the light, and which do not give direct tests of the engine-power are, I consider, totally unreliable.

Considerable credit is due to Professors Ayrton and Perry for taking the initiative in such a matter. Their tests serve to point out the great difficulties there are in the way of arriving at a satisfactory comparison of different lights.—Yours, &c.,

Henry F. Joel.

Queen's Buildings, 52, Queen Victoria-street, E.C.

WATER-POWER FOR THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: At the recent Paris Electrical Exhibition there seemed to be no other power but steam or gas to generate electricity for electric lighting.

If some arrangement could be made for showing what water with turbines or wheels can do in this respect I believe the forthcoming exhibition at the Crystal Palace would do something for its introduction into country mansions, houses, and factories.

The necessity for a steam or other engine must in many cases prevent the owner from entertaining the idea; but with a stream running near, if it is shown that there is sufficient force to drive a dynamo machine which will give the required light, the greatest source of expense is overcome.

From some inquiries I have lately made I am surprised at the difference in the estimated force of a given quantity and fall of water, one turbine maker giving it as equal to ½ horse-power, and another as high as 7 horse-power.

Some reliable results at a public exhibition would certainly be useful.—Yours, &c.,

W. H. A.

TRAIN LIGHTING: ELECTRICITY OR GAS?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the serious accident on the North London Railway on Saturday last it gives us a warning of the dangers attached to the system of lighting trains by gas, which is stored in bags at the rear of the train. At the time of the accident there was a quantity of gas liberated in the

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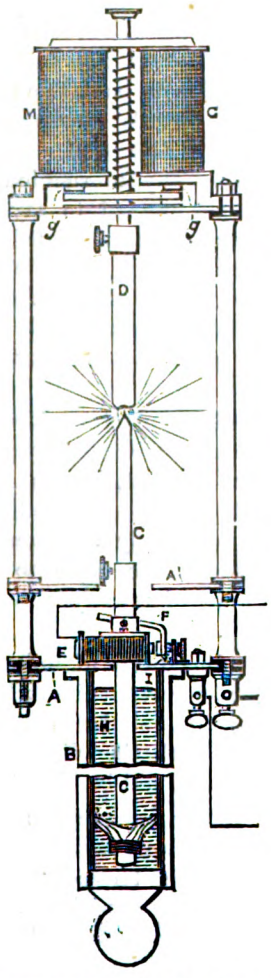
tunnel, which gas, fortunately for everybody, merely managed to get away; had it exploded (it is a mercy it did not) the results would have been shocking, and very few of the passengers would have escaped. Considering the perfection we have now arrived at with the electric light on the incandescent system, which gives us a beautiful light free from danger and obnoxious fumes—under these conditions it seems strange the railway companies do not appear to be at all anxious to adopt this method of lighting. What could be more simple than having a small dynamo machine fixed in the break van, worked by a band or other suitable means from the axle of the train, a few secondary batteries or accumulators, which would regulate the light when running and supply the lights when stoppages were made. The guard would, after a few lessons, attend to the machine and batteries as easily as he now attends to his oil lamps; the cost after the first outlay would be less than oil and lamp men, and the benefit derived from this source of lighting would be beneficial and appreciated by all.—Yours, &c.,

28, Culford-road, N., Dec. 12, 1881. W. A. KENT.

THE "HAWKES" ELECTRIC LIGHT.

A new form of arc lamp has been patented by the inventors, Messrs. Geo. Hawkes and Co., of 9, Victoria-chambers, Westminster, which we illustrate below. The top of the lamp contains a small electro-magnet M, placed in the main circuit, which separates the carbons D C, when the lamp is circuited by



attracting an armature *g*, fixed to the top, or positive, carbon holder.

The bottom, or negative, carbon holder C is immersed in a column of mercury contained in a glass tube protected by a metal casing B.

Complete connection is maintained by means of a wire fitting tightly in an india rubber plug fixed in the lower end of the glass tube. This wire comes into contact with the inner column of mercury, and is also immersed in a smaller quantity of mercury contained in the metal tube.

The regulating gear is simple, and consists of a small magnet E fixed to the bottom plate in a branch circuit, with its armature attached to a clutch or jambing-ring turning upon two pivots or centres, fixed in such a way that when the magnet attracts its armature it tightens the jambing-ring, which in turn clutches the lower or negative carbon-holder which passes through it. This clutching gear is so regulated as to allow the carbon to ascend at proper intervals, according to the size of the arc. To regulate the magnet a "governor" is provided, consisting of two solenoids, one placed in the main circuit and the other in the shunt circuit, with an oscillating armature swinging between their poles, so as to be attracted more or less by one or the other. A platinum conductor is fixed to this armature, and when the solenoid in the main circuit is most active the platinum is brought into contact with a similar conductor, which establishes the shunt circuit.

When the resistance in the main circuit has increased, a greater percentage of the current is forced into the shunt circuit, thereby increasing the power of the solenoid placed in it, and attracting the armature to it, which therefore separates the platinum conductors, the solenoid in the main circuit being overpowered.

A contact-breaker is placed in the shunt-circuit, and so connected that when the platinum points are in contact it is short-circuited; when, however, the points are separated it is immediately circuited.

The contact-breaker is a small mechanical contrivance, making about 30 revolutions per minute, worked by the motive power by which the dynamo-machine is driven, and at every revolution the circuit is broken for a moment only.

The design of the inventors is to do away with the regulating mechanism to be found in other lamps of the same kind. The lamp was exhibited some few days since at Messrs. Hawkes's temporary laboratory, No. 80, Gray's-inn-road, W.C., when the light was fairly steady. A better opportunity of judging of the merits of the lamp will be afforded by the approaching Crystal Palace Exhibition, at which it will be exhibited.

THE EDISON ELECTRIC LIGHT COMPANY.

The following is a report of the annual meeting of the stockholders of the Edison Electric Light Company, which was held in the last week of October at the company's offices in Fifth-avenue, near Fourteenth-street, New York. The purpose of the meeting was the election of a board of trustees composed of 13 members, and the discussion and adoption of the annual report summarising the transactions of the company for the last year. The report set forth, in opening, the manner in which the indebtedness of the company contracted during the year 1879 was liquidated by authorising the board of trustees to borrow of the stockholders a sum equal to 60 per cent. of their stock, and to issue in consideration of such loan certificates of indebtedness convertible at par into shares of the capital stock. In November, 1880, an increase of the capital stock from 300,000 dollars to 480,000 dollars—the present figure—was duly sanctioned at a special meeting, and the certificates were redeemed by the issue of new shares. The exhibition of the electric light at Menlo Park last winter, which occupied two or three months, was next adverted to as having proved the practicability of the Edison system and demonstrated its economic success. Six hundred lamps were kept lighted for weeks and six miles of mains were laid in the streets of that village. In January last Mr. Edison announced that his system was perfected, and experiments were discontinued. The next step was to test the system on large scale for street and house lighting, and for this purpose a tract in New York city was selected. It was found, however, that the Edison Electric Light Company could not obtain leave to lay mains beneath the streets, and a new company, known as the Edison Electric Illuminating Company, had to be incorporated under the gas statutes of the State before the work of laying the mains could be commenced. This was done last spring, and contracts between the two companies were signed as a condition before proceeding to further action. In the same manner, in June last, it was resolved to form a special company for the development of the electric railway, for whose exhibition Mr. Henry Villard is now building two and a half miles of road at Menlo Park, under a contract entered into in September last. The lighting of railway trains and steamships by electricity has not yet received the full attention of the Company, and no new movements will be made in these directions until the completion of the station in this City, and the lighting of the proposed district have been successfully accomplished. The steamships "Columbia" and "City of Worcester" are now lighted by the Edison system. The business of supplying isolated plant for dwellings and manufactories has developed rapidly under the superintendence of Mr. Moore. The Orange Woollen Mills, Newburg; the Baldwin Locomotive Works, Philadelphia; the factory of Hinds, Ketcham, and Co., New York; the Prospect Park House, at the Adirondacks and the Newburg factories are among the establishments in which the system is in successful operation.

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THE ELECTRICIAN.

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UNDERGROUND TELEGRAPH WIRES.

There can be little doubt amongst those who watch the general direction in which the wind blows in telegraphic engineering that there is a steady breeze blowing towards underground wires; and those who are wise and have any responsibility in the matter will do well to consider the question impartially, and without prejudice.

First, let us consider the *raison d'être* of underground wires. Suspended land wires were, no doubt, in the early days of telegraphy the most economical and feasible means of providing conductors between stations when one, two, or three wires were all that was required. And we will go so far as this—that as long as the poles on one side of a line of railway could carry all that was required without any overstrain on the particular class of poles erected the system (originated by the earlier introducers of the electric telegraph in this country, viz., Messrs. Cook and Wheatstone) was the right system. But the earlier lines were erected, regardless of expense, of solid square poles cut out of foreign timber. These square cut poles were in advance of their age. They were too good for the work they had to perform at that period, namely, to carry some four or five wires. Soon after the new engineers of the Electric Telegraph Company gained credit for economy by sweeping away foreign timber and substituting English larch poles. No doubt this was at first an economy, but as time went on these larch poles were crowded with wires. But circuits increase almost in geometrical ratio to the time elapsing since the first circuit is established. Very soon the foreign timber would have been more in place than the weak, and in some cases crooked (and in nearly all cases unsightly), larch poles.

By degrees the crowded larch poles have had to be doubled—that is, a second set have had to be placed on the opposite side of the railways along which the first lines run, and now these are crowded up to eighteen, twenty, and we are afraid to say how many wires. Even if snow storms never came in to give a check to this tempting of Providence, there would certainly soon be a limit to the number of wires that can be placed on one set of poles. Unless, therefore, the height of the poles is greatly increased, a third row of poles would be required, and where are they to be placed?

Subterranean wires, now advocated with ostentation by the Germans, were long ago tried by the old Electric Telegraph Company, but *they* were before their time, or else were badly served. We cannot search dates, but certainly anybody who inquires will find that some thirty years ago the Electric Telegraph Company laid down subterranean wires to Manchester. These were removed. An official and legal inquiry could only elicit the particular reason why. Many years afterwards (those interested must search for dates) subterranean lines were laid between Manchester and Liverpool, under the immediate superintendence of Mr. George Preece; and here the system of joint testing employed in submarine telegraphic engineering was for the first time brought into action in land line work. The lines were a complete success as regards construction, and we believe have lasted very well. There is, of course, a certain amount of difficulty in getting any information on these subjects, and therefore we do not pretend to say how far these lines, which were copper conductors insulated with gutta percha, and protected by tape and Stockholm tar, have proved successful. But it is pretty generally admitted that gutta percha covered wires in many places are liable to dry up and crack, and also become in some localities attacked by a kind of parasite.

Other materials and manufactures have a claim to hearing, and, without presuming to advocate any particular process, we only wish to point out that, though gutta percha covered wires were hastily adopted underground, and abandoned some thirty years ago, it is scarcely a reason why, at the present date, no attempt should be made to supplant the overburdened double line of railway pole telegraphs by some underground system.

We admit all the difficulties of induction, and it is quite possible that for our longest circuits to Ireland and the north subterranean lines could only be adopted with a great loss of speed, particularly with the Wheatstone automatic; but surely *some* of the lines could be placed underground.

The Post Office authorities ought really to consider this question. Germany has been laying down rather recklessly, we think, what may be termed "compound submarine cables," and will gain some experience, no doubt, when one wire of the compound series fails. The Germans are always ahead of us to the extent of imitating us in the wrong place; but, at any rate, they have some wires underground (possibly only capable of satisfying 40 or 50 words a minute), whilst we are used to 150 to 200 by the Wheatstone automatic. Therefore we must not rush at conclusions. The Imperial German Government aims at a war telegraphic system that will stand less chance of being interrupted than the conspicuous land line system. Their underground system

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satisfies their ideas—safety in war—slowness in peace. We want quickness always if possible, but at any rate *some* rate during snow-storms. Therefore, if overhead wires are frequently being blown down the question of underground must be seriously considered. If gutta percha really dries up and perishes to such an extent, which, however, we feel bound to deny, that abroad it has always to be laid in pipes maintained full of water, surely any other material that has any promise should be liberally experimented on. Hooper's core has never had a fair trial in subterranean wires, and Mr. W. T. Henley's ozokerised india rubber core is still in its infancy. It is impossible to go on overburdening the telegraph poles on our trunk lines with more wires, and therefore the sooner the Post Office consider the question with that impossibility in view the better.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

II.

Measure of the Strength of a Magnet and of a Magnetic Field.

The space in the neighbourhood of a magnet being found to possess peculiar properties, it is called a magnetic field, or field of force. Strictly speaking, the field of a magnet extends through all space not bounded by a perfect conductor (if there be such a thing); but practically it means the immediate neighbourhood of the magnet.

A freely movable pole, placed at any point of such a field, is urged with some force along a certain curved line, which line is called the line of force passing through that point. Through every point chosen at random a distinct line of force can in general be drawn, and the aggregate of all these lines of force constitutes the magnetic field.

A line of force, then, is a line along which a magnetic pole without inertia will move if perfectly free. In other words, it points out the direction of the magnetic force at every point of its length. The direction only—not the magnitude.

Such a line always sets out from one pole of a magnet, and returns to the other pole. It is in fact simply a continuation in air of a magnetic *axis* in the magnet.

From an ideal simple magnet,* therefore, lines of force start from the ends, and from nowhere else. From an ordinary magnet a line of force springs from every point, except a neutral line near the middle—from every point, that is, where a termination (or pole) of any magnetic filament of the bundle occurs.

To specify the intensity of the force at any point, we must state what force a given magnetic pole would experience if placed there; hence we must first inquire how the strength of a magnetic pole is to be specified.

As it is intrinsically impossible to examine what the action of one pole on another may be, any measurement founded upon such hypothetical action cannot be considered thoroughly ultimate and satisfactory.

Still we can, by using long magnets and keeping one pole of each quite out of the way, examine with more or less exactness what is the action between the other two poles. This was the method adopted by Coulomb in his classical researches in magnetism and electricity, which were the first accurate measurements that had been made. He proved that within the limits of experimental error the force of attraction or repulsion between two unlike or like poles varied inversely with the square of the distance between them; and his device of the torsion balance as a means of measuring these small forces has been ever since regarded as the fundamental experiment on which the whole of the electrostatic and magnetic system of measurements are based.

We will have nothing here to do with electrostatics, but the foundation of the magnetic system of measurement is most important. We do not assert that it is the best or the ultimate principle of measurement by any means; but we do assert that it is the one now universally used. And for a great many purposes the important thing is to have a unit accurately defined and thoroughly established, whether that unit be an arbitrary and intrinsically unsatisfactory one or not.

A magnetic pole, then, is said to be of unit strength when it repels a similar equal pole at unit distance from it with unit force. And a pole is said to be of strength 2, when at unit distance it exerts two units of force on a unit pole, of strength 5 when it exerts five units of force on a unit pole; and so on. The unit of force all over Europe (thanks to the Paris Electrical Congress) is now the C.G.S. unit, called a dyne. A dyne is about the 981th part of the weight of a gramme—*i.e.*, about the 157th of the weight of a grain. A unit pole, then, is one that repels a similar equal pole one centimetre away from it with the force of a dyne. These small forces can readily be estimated by a torsion balance.

If the force between two equal poles one centimetre apart is found to be 64 dynes, each must have the strength 8. Remove them to a distance of two centimetres and the force between them would be only 16 dynes.

If two equal poles (say the two poles of a single long flexible magnet) were found to attract one another with a force of 36 dynes when brought within three centimetres of one another, then we should know that the strength of each pole was 18. That is, 18 magnetic units.

The intensity of a magnetic field at any point can now be expressed. It means simply the number of dynes which a free unit magnetic pole would experience if placed there.

To measure the strength of a magnetic field we have to place a known pole in it, and hold it still by a force whose magnitude we can determine. Thus if a pole of strength 8 requires to hold it still a force of 3,200 dynes, then we know that it is in a field whose intensity at the position of the pole is 400 magnetic units.

And a field of unit intensity is that which acts on unit pole with unit force.

The intensity of a field will in general be different at different points of it. To express the strength of a field in a convenient manner, Faraday made the most ingenious use of his conception of lines of force, which it is most important for us clearly to understand.

The primary use of a line of force is, as we have said, to point out the direction of the resultant force which a magnetic pole would experience if placed anywhere on the line—the pole will be always urged along the line. A single line of force can do no more than this.

But if we draw a number of lines of force so as to map out all the magnetic field of a magnet, it will be evident that in the parts most removed from the magnet, where the intensity is least, there the lines of force will be few and far between. Whereas close to either pole, where the intensity is known to be considerable, the lines will be crowded together. Even without going into any magnetic theory, it is evident that this must be so from the simple fact that every line of force sets out from one pole and returns to the other, spreading out more or less through all space.

Hence the distance between consecutive lines of force is a sort of measure of the weakness of the field.

Consider the field of force due to a single magnetic pole. It is evident from symmetry that its lines of force must be simple, straight spokes, radiating equally in all directions like rays of light. And just as in light the number of rays falling upon a square centimetre vary inversely with the square of the distance, so it will be with the lines of force. The number passing through a square centimetre held perpendicular to them will vary inversely with the square of its distance from the pole—that is, will vary precisely as the intensity of the force varies. The lines of force have no more (and no less) physical significance than the rays of light—but the conception is a very convenient one in both cases. The "brilliancy" of any part of a field of light will be evidently proportional to the closeness of the rays of light in that region; if we may mean by "brilliancy" the quantity of light which would be received by unit area if placed there. But as we know a field containing rays of

* In defining this last week we said it had only one axis. This is true, if by an axis we mean a direction, as is correct; but if for convenience we mean a line, then we may say that it has all its axes parallel, or that it is built up of parallel magnetic filaments.

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light is perfectly dark unless a body is placed in it to show the illumination, we ought more properly to call the number of rays passing through a contour of unit area at any point, the "potential brilliancy" or "potential illumination" at that point. Just so with magnetism. A field containing lines of force is perfectly forceless at every point where there is not a magnetic pole to be acted upon, and we ought to call the number of lines of force passing through a contour of unit area drawn round any point perpendicular to the line of force, the potential force or potential intensity of the field at that point. But, for shortness, this meaning has been given to the word intensity alone, so that *the magnetic intensity at a point* means precisely this—the number of lines of force passing through unit area drawn about that point and perpendicular to the lines. But the magnetic intensity at a point also means the force which unit pole will experience if placed there. And since the closeness of drawing the lines of force is quite arbitrary and has not yet been settled, we can make the two definitions coincide by arranging that the number passing through unit area at any point of the field shall exactly express the force on unit pole at that point.

If this is done for any one point it will be right for every other, since the two things have been seen to be proportional.

We will now, therefore, restate the whole.

The intensity of a field at any point means the force experienced by unit pole at that point, and is equal to the number of lines of force passing through a perpendicular square centimetre containing that point.

These ideas are not without their difficulties, the principal difficulties being that the number of lines of force is essentially a discontinous quantity, and that it is not the mere lines, but the space *between* the lines (*i.e.*, the whole space), that is the really important matter; and hence has arisen the idea and name "tubes of force." Now, it is certain that tubes of force lend themselves more readily to accurate mathematical statement, and probably also to accurate mathematical conception; but the conception of lines of force is an easier one for the non-mathematical mind, and the difficulty is no greater than, but is precisely of the same nature as, that which is (not ?) experienced in dealing with rays of light; and it is readily got over by imagining them close and numerous enough.

In a uniform field of force the lines of force are parallel. Such is practically the case all around us, at least at reasonable distances from masses of iron, and the existence of this field of force is popularly accounted for by saying that the earth is a magnet.

The measurement of the intensity of this field is a most important determination.

At present in London the earth's lines of force slope downwards at an angle of about $67\frac{1}{2}$ degrees to the horizon, and tend northwards at an angle of, say, $18\frac{1}{3}$ degrees west of the true north and south line.* And the force with which a unit pole is urged along one of these lines is ·47 dyne. This force may, of course, be resolved into a horizontal and vertical component by multiplying it by cos $67\frac{1}{2}$ degrees and sine $67\frac{1}{2}$ degrees respectively; the horizontal component (called the earth's horizontal intensity) comes out ·18 dyne, and the vertical ·44.

Hence through every square metre of horizontal surface we may picture to ourselves 4,400 uniformly distributed straight lines passing through at the proper angle and direction.

Through every square metre of vertical surface the number varies with the aspect of that surface, from none when its azimuth is $18\frac{1}{2}$ degrees west, to 1,800 when its azimuth is $71\frac{1}{2}$ degrees east.

A vertical plane not cut by any lines is called *the magnetic meridian.*

Behaviour of a Magnet in a Magnetic Field.

If a magnet perfectly free to move is placed in a field of force, one pole tends to move along a line of force in one direction, and the other pole tends in a direction precisely opposite; it will, therefore, set itself along the lines of force. But, unless the field of force be uniform, one pole will be more solicited than the other, and the whole magnet will move in the direction in which the lines of force are closest, and will sail on until it strikes a pole.

In a uniform field, however, no such motion of the magnet, as a whole, will be produced; it will only rotate till it points along the lines. The strength of a magnet must be measured by the couple required to forcibly hold it at right angles to the lines of force in a field of unit strength. The moment of this couple is called *the moment of the magnet.*

By the ordinary definition of a couple we see that, for a simple magnet, the moment must be the strength of either pole multiplied by the distance between them; for the force exerted on a pole in a unit field is precisely the numerical measure of its strength.

For an ordinary magnet the moment is the algebraic sum of the moments of the bundle of simple magnets of which it is made up, but it is not separable into two factors (the strength of each pole into the distance between them), except in a roughly approximate manner.

The total couple experienced by a horizontal magnet placed at right angles to the magnetic meridian is ·47 times its moment. The couple experienced by a horizontal magnet placed in the magnetic meridian is ·44 times its moment.* The couple experienced by a vertical magnet is ·18 times its moment.

The couple experienced by a magnet in any position in a uniform field is simply the moment of the magnet multiplied by the strength of the field multiplied by the sine of the angle between the axis of the magnet and the lines of force.

Field of a Magnet.

The intensity of the field produced by a magnet at any distance from itself depends on its moment and on some function of the distance and size of the magnet.

For a very short magnetic filament (or simple magnet) the intensity of the field at unit distance from its middle in a direction at right angles to its axis is equal to its moment; and at unit distance *along* the axis, it is *twice* the moment of the magnet: the direction of the force in these two cases being exactly opposite.

In intermediate positions the force has intermediate values, both in magnitude and direction.

For other distances the intensity varies inversely with the cube of the distance. All this is easily shown by simply adding the effect of the two poles separately, remembering that each pole by itself produces an intensity equal to the strength of the pole divided by the square of the distance from it.

THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.†

The teaching of physics, as far as electricity is concerned, is yet very imperfect, not only in colleges, but even in engineering schools. Electricity is still considered from a telegraphic point of view, or in connection with apparatus of precision, and the production of very feeble mechanical effects.

Nevertheless, those who have studied the subject know that the function of electricity is far more extensive; and the recent exposition of electricity at Paris has brought the fact home to everybody. It was shown there that electricity is fitted for the generation and transport of any desired mechanical power; a result fraught with illimitable consequences.

Despite some interesting studies, this new application of electricity is embarrassed by doubts and contradictions, and it is the author's aim to clear these away by expounding the fundamental laws of the transport of energy by electricity. He does not hesitate to go back to first principles, and will be scrupulously carefully to define and demonstrate in order to render his

* This angle is by sailors inconveniently called the *variation* of the compass, by landsmen it is inappropriately termed the *declination*, and by others it is absurdly styled the *error*, as if the compass ought by rights to have pointed due north, but did not. The proper name for it is the *azimuth* of the compass.

* In an ordinary compass needle the vertical component of the couple is purposely neutralised by loading: the residual couple experienced by such a needle, therefore, when in the meridian, is 0; and when at right angles to it, is ·18 times the moment of the needle.

† An article by M. Marcel Deprez in *La Lumière Electrique*, translated and abridged by J. Munro.

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explanation solid. Only the most elementary formula and the simplest physical principles will be employed in doing so.

To begin with, let us recall what is meant by the word "energy." This term comprises the work done of every kind. We know that all physical phenomena, of whatever nature, thermal, chemical, and so on, can be measured in units of work —for example, in kilogrammes, or foot pounds. Conversely, if we have a certain quantity of energy in a measurable form, such as the mechanical work done in moving a dynamo-electric generator of electricity, we can employ it either to produce a single form of energy, say heat, or to produce divers forms of energy, heat, chemical action, motion, &c.; and by the principle of the conservation of energy the sum total of the energy produced is equal to the work expended.*

Definitions and Principles.

I.—*Definition and Measure of the Intensity of a Current.*

Amongst the effects produced by the passage of an electric current we will first consider chemical action. The simplest examination shows it to be a function of the *intensity* of the current, for we find it to vary with the variations in the intensity. Without being too precise, we may say that equal chemical actions correspond to equal intensities, and conversely. This fact was the first to serve as a means of measuring current electricity.

The Laws of Faraday.

(*a*). The laws which regulate electro-chemical actions were discovered by Faraday, and the first may be expressed as follows:—In any given circuit traversed by an electric current, whatever be the nature and arrangement of the successive conductors composing the circuit, the chemical work, and consequently the intensity, or in other words the quantity of chemical action, and of electricity flowing per second, are the same at all points of the circuit.

(*b*) This law is verified by placing a number of voltameters of different size and conductivity in the circuit of a battery, and observing that the quantity of gas liberated in each of them during unit time is the same.

(*c*) The chemical work and intensity of current is the same not only in the apparatus joined in circuit, but also in the battery itself. This can be shown by making the battery of a zinc plate and a platinum plate immersed in acidulated water, and covering the platinum plate with a bell-jar. On closing the experimental circuit the hydrogen is seen to liberate itself on the platitum plate in equal quantity to that in the voltameters connected in the rest of the circuit. The battery itself, in short, acts like another voltameter submitted to the current.

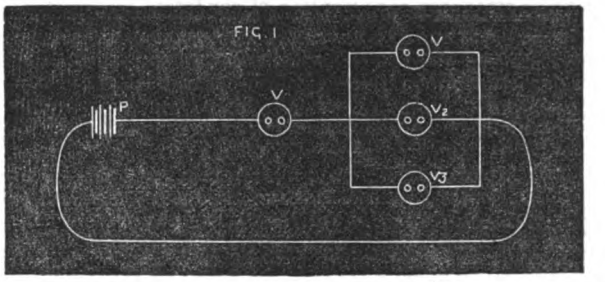
(*d*). Pushing the experiment still further, we can employ the gas battery of Grove as a generator. This may be regarded as a voltameter having its bells filled with hydrogen and oxygen respectively; and if the platinum plates immersed in these gases are connected by a wire, a current is found to flow in the wire. On making a circuit with a gas battery and a number of voltameters, we shall see that the quantity of gas absorbed in each element of the battery is equal to that which is liberated in each of the voltameters. If, then, the gas battery be reduced until it has fewer cells than there are voltameters, the latter will in turn become generators, and the current in the circuit will be reversed. The chemical actions performed in the same circuit are, therefore, always equal, whatever be their situation or their direction, that is to say, whether positive and used to create the current or negative and produced by the current.

The preceding examples only suppose that equal intensities of current correspond to equal chemical actions, but the precise relationship between them is stated thus:—

(*e*). Chemical action is proportional to the intensity of current.

This is demonstrated by the arrangement shown in Fig. 1, where the current from a battery P after passing through a voltameter V is split into three equal parts by three circuits of equal resistance including voltameters V_1 V_2 V_3. The strength of current in each of these three circuits is one-third of the whole, and consequently the quantity of gas liberated in each of the three voltameters V_1 V_2 V_3 is one-third of that liberated in V.

Hitherto we have assumed the same chemical action to take place in every part of the circuit; but the law holds good for different actions; only in this case the weights of the bodies de-



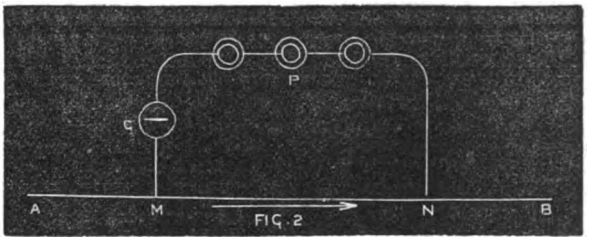
composed by the current are no longer equal to each other, but proportional to the chemical equivalents to the substances involved. As zinc is in general the substance dissolved in a battery, we can state this law of electro-chemical equivalents thus:—

In any voltaic circuit in which a current produces chemical actions there are as many equivalents of zinc dissolved in each of the elements of the battery as there are equivalents decomposed in each of the apparatus of electrolysis, always supposing that the elements and the apparatus are connected in series.

II.—*Definition and Measure of Electromotive Force.*

Electromotive force is a name given to the cause which puts electricity in motion in a circuit. It is estimated in a simple manner by the number of cells in a battery when joined up one after another "in series" or "in tension"—that is to say, the negative pole of the preceding cell joined to the positive pole of the next.

Tension is a special mode of electricity, and indicates the state of accumulation in which it exists. Suppose, for example, we take a Daniell cell with open circuit, we shall find a difference of electric tension between its poles, which is the greatest that that battery can produce, and equal to what we call the electromotive force of the battery. In fact, electromotive force is only known to us through the difference of tension which it produces and by which it is measured. If we connect the two poles to earth by wires we shall find that the tension of each pole goes on decreasing till it is *nil* at the earth. The



different points of the circuit have then, in mathematical language, a diminishing potential, and we can measure the differences of potential by taking the difference of tension between the poles of a Daniell cell as a unit. Motion of electricity, that is to say the electric current, can only exist between two points if they are at different potentials. We cannot conceive an electric current between two points in the same electric state any more than we can conceive a flow of liquid between two points at the same level. Hence we arrive at a direct means of measuring the difference of potential between two points.

(*a*). Let us take the two points M and N, Fig. 2, situated in the circuit A B, in which an electric current passes in the direction A B. We connect them by a derived circuit M P N, comprising a galvanometer, G, or other instrument for indicating a current. The galvanometer at once shows a derived current in the direction M P N; but on interposing cells of a battery, P, this current can be annulled and the galvanometer needle brought to zero. When this takes place the electromotive force of the battery interposed is equal to the difference of potential between the points M and N. With such a means of measuring electromotive force we can examine how a current varies according to the conditions affecting it.

(TO BE CONTINUED.)

* This principle can be expressed in a general form by the equation—

$$T = A + C + T\,m + \frac{(\Sigma\, m v^2 - \Sigma\, m v_0^2)}{2},$$

where T represents the value of the work expended in moving the generator; A the chemical action; C the thermal effect, T *m* the mechanical work done by a motor, and $\frac{(\Sigma\, m v^2 - \Sigma\, m v_0^2)}{2}$ the energy wasted in the organs of the motor.

Remark that electricity does not appear in this equation; there is, in fact, no means of introducing it; electric work has no expression, and does not exist in a form of its own. It always manifests itself under the form of heat, chemical, or other energy, and not in a special fashion, except in the case of condensed electricity. Then only we have electric work, and we are therefore led to conclude that electricity is not one of the forms of energy, but simply its vehicle. This striking consideration ceases to appear strange when we reflect that in work done electrically there is no loss of electricity. As we shall see further on the latter is intact after yielding various sums of energy, a result which would be absurd if electricity itself were energy. The only factor which is modified in such a case is the potential, not the quantity of electricity. It is the potential which represents energy, and not the electricity itself. Electricity is no more a form of energy than a column of compressed water or a belt conveying power from an engine to a lathe.

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ELECTRIC LIGHTING AT THE PARIS EXHIBITION.*

By William Henry Preece, F.R.S.

The recent International Exhibition of Electricity in Paris marks an epoch in the history of the practical applications of that science to arts, manufactures, and commerce. I propose to-night to refer only to its application to artificial illumination; but there are many other branches fully deserving examination and discussion by this society. It was, however, as an exhibition of electric lighting that it was principally attractive, and those who saw it for the first time will never forget the vivid impression that the great blaze of splendour produced upon their minds on entering the building. There never can be anything like it again, for as wisdom grows with experience, so no manager of any future exhibition is likely to repeat that terrific *mélange* of lights that flooded the interior of the Palais de l'Industrie with great brilliancy, but with an impractical and impossible means of comparing and judging the relative merits of different systems.

For instance, at the forthcoming exhibition at the Crystal Palace, the building—splendidly adapted for the purpose—will be divided into sections, each section being lit by one, and only one system. But at Paris, Pelion was piled upon Ossa; the British Section, for instance, received rays from at least a dozen different sources. To estimate the value of a Siemens lamp you had to eliminate the disturbing influence of a blazing Crompton; and to admire the star-like Jasper arc, you had to run the gauntlet of a flock of Swans. The fretful Jamin, or the fitful Jablochkoff, were masked by the steady Gülcher or the brilliant Serrin. In the galleries, however, it was different. Here, different *salles* were illuminated by different systems; a small theatre was lit by the Werdermann lamp, and a picture gallery most effectively shown up by the *Lampe Soleil*; a buffet was softly and brightly lit up with the Swan lamp, while Mr. Edison's numerous exhibits, in his own *salons*, were as visible by night as by day, thanks to his own beautiful lamp.

It is not my intention to examine, *seriatim*, the various machines, lamps, and modes of illumination shown. With most of them you are already familiar. But I purpose to select what appeared to me to be novelties, and what seemed worthy of bringing to your notice, as steps in advance.

On the night of August 29th, there were in operation 277 arc lamps, 116 candles, 44 arc incandescent lamps, 1,500 incandescent lamps, or a total of 1,837 electric lights in all, at the Paris Exhibition. Towards the end of the period during which the show was opened this number was very largely increased, and I have little doubt that the number reached 2,500 in the beginning of November. Now this army of lamps required power to convert the energy stored up in coal into energy of motion; dynamo-machines to convert the energy of motion into electrical energy; conductors to transport this electric energy to the point to be illuminated; lamps to convert the electric energy into energy of heat, and therefore of light.

The exhibition of engines and machinery was very extensive, although our English manufacturers failed to do what they might have done had they thought as highly of the exhibition at first as they did afterwards. Many of our manufacturers were conspicuous by their absence. The only extensive display was by Messrs. Robey and Co., of Lincoln, who showed eight of their well-known engines, with a total power of 250 horses, and I have every reason to believe that their success has amply repaid them for their enterprise. Mr. Brotherhood made a small show, and Messrs. Wallis and Stevens, of Basingstoke, sent one of their semi-fixed steam engines, with their pretty and effective governor for adjusting the speed while in motion, uniformity in speed being an essential criterion of an electric-light engine. The foreigners, for a wonder, far outshone the British in the magnitude of their displays.

One of the most valuable exhibits was made by Messrs. Thomson, Sterne, and Co., who showed a new gas-engine on a new principle, which attracted a great deal of attention. Gas is destined to play a most important *rôle* in the future of electric lighting. Its function is that of a heat-generator. The energy of the coal exists in gas in a form which can develop more light, when converted into the form of electricity by the current, than in the form of heat by combustion. Gas-engines have a very high theoretical efficiency, and they are free from the dangers of boilers, the neglect of stokers, or the waste of energy in chimneys.

Gas engines on the "Otto" principle, from half horse-power to fifty horse-power, were very extensively exhibited by France, but the machine of Thomson, Sterne, and Co. (Clark's patent) excelled them all in lightness, compactness, regularity, and safety. One of these engines may now be seen at work at the Smoke Abatement Exhibition at South Kensington, and several have been ordered for private houses. As an adjunct to the gas engine, Mr. Dowson exhibited an interesting and valuable process of making cheap gas for motor purposes. Professor Ayrton reported that in a series of trials made with a three-and-a-half horse-power (nominal) "Otto" engine, driven by the Dowson gas, one horse-power (indicated) was obtained per hour by the consumption of gas derived from 1·46lb. of coal. For larger engines he anticipated a consumption of only 1·2lb. per indicated horse-power per hour. You will have a paper during the Session by Mr. Dowson himself, describing his mode of manufacture. When, perhaps, 6lb. of coal per horse-power per hour are consumed in the present electric light steam engines, you can form some idea of the economy to be effected by cheap gas.

Dynamo machines—machines which convert the energy of motion into electrical energy, through the medium of magnetism—were exhibited in abundance, of all kinds and forms, from the original apparatus of Faraday, made with his own hands, to Mr. Edison's latest development of this wonderful source of electric currents. There are two kinds of machine—the one producing currents from fixed and permanent steel magnets, the other from electro magnets, excited by the currents which they themselves generate. Each kind is also sub-divided into two others, in one of which continuous currents are produced, flowing in one direction, called the continuous current machine; and in the other alternate currents, called the alternate current machine, where the current rapidly reverses and changes its direction. The production of currents by these machines is due to the simple fact discovered by Faraday, that if a conductor, such as a copper wire, be moved rapidly through a magnetised space or a magnetic field, as it is called, this conductor is electrified, so that if its two ends be connected a current flows. The intensity of this current depends, first, on the intensity of the magnetism present, on the velocity with which the conductor moves through the field, and on the direction with which it cuts the lines of magnetic force which permeate the magnetic field. The magneto-electric kind—the manufacture and invention of M. de Meritens—are very much approved of by our Trinity House for lighthouse purposes, and a very fine display of them was made by M. de Meritens, who seemed to live in the Exhibition, for he was always there, and who never seemed to tire of giving his clear and able descriptions. He exhibited alternate and continuous current machines, and he richly deserved the gold medal that was accorded to him. The exhibition of dynamo-machines was rendered very interesting by the exhibition of an early machine of Elias, of Haarlem, of 1842, and of Pacinotti's machines of 1861. The former was shown in the Dutch Section, and the latter in the Italian. Here we have the germs of all the present machines, and by whatever name a machine may be known, it can be traced back to these original types. The Pacinotti apparatus has been very greatly improved by Gramme and by Siemens—forms well known to every one—but it has received its greatest development in the Edison machine, which was one of the wonders of the Exhibition. As this was one of the greatest novelties I must briefly describe it. In the first place, I must must point out that the machine is larger than any one that has ever been made before. It weighs twenty tons, and it can produce a current of electricity of nearly 900 ampères.* Now, when the longest machine of the Gramme type weighed scarcely a ton, and produced a current of but 93 ampères, the difference becomes striking. Now, Mr. Edison has struck out three new paths in the bulk and form of his electro-magnets, two in the size and construction of his armature, and three in the low resistance of his revolving coil. By the first, he secures an intense and concentrated magnetic field, by the second he secures a high cutting velocity for the moving conductor through this field, and by the third he secures a very powerful current to be distributed among a great number of lamps with the least possible waste of energy. The long and bulky coils, 8 feet long, which constitute his electro-magnet, have excited the surprise of many electricians, but there is no doubt that he has arrived at this form after many careful practical experiments, supported by the mathematical investigations of Professor Rowland—a very high authority—and that the result is to obtain an intense field in a large space, with the least absorption of electrical energy in the coils. With 350 revolutions per minute he is able to produce an electromotive force of 110 volts, which an ordinary Gramme machine can only attain with over 1,000 revolutions per minute. His field-magnets are wound with wire, which have a resistance of 30 ohms, and which are connected as a shunt to the main circuit, as was originally done by Wheatstone, and is now followed by Dr. Siemens and Sir William Thomson. The armature is not wound with wire, but is constructed with solid bars of copper ⅜in. by ½in. section, and 3½ft. long, which are well insulated from each other, and are most ingeniously connected at their ends by copper discs, so that all the bars, of which there are 138, form one continuous circuit, whose total resistance is only 0·008 of an ohm. The diameter of the armature is 28 inches. The core of the armature is made up of 1,700 thin iron discs insulated from each other by paper, and well clamped into a solid mass by bolts. This is done to avoid the heating effects due to so-called Foucault currents induced in the metal and absorbing or wasting energy. The iron core of the armature becomes thus magnetised, and it concentrates the field to the space through which the conductor moves, as is done in Siemens's and other machines.

There are two great troubles in existing machines, want of uniformity in their motion and the slipping of belts. The former is met with by governors, and the latter by direct gearing. Steadiness of motion is essential, otherwise we have that painful throbbing of the light that is so irritating to the eyes. Mr. Edison connects his armature direct to his steam motor, which is a high-pressure engine of the Allen-Porter type, governed by an ingenious centrifugal regulator, and rotating very uniformly at 350 revolutions per minute, without any multiplying gear whatever. When the machine is giving out its maximum commercial effect it absorbs 125 horse-power, the external resistance should be 16 times that of the armature—the electromotive force 110 volts, and the current consequently 860 ampères. It is not safe to exceed this limit, for the armature then becomes unduly heated. A special blower is added to direct cold air on the armature to keep down the heat, when the work of the machine approaches its limit. The brush is a special feature of this machine. The absence of sparking was very striking. Mr. Edison coats his brush and commutator with an amalgam of copper, which diminishes the electrical resistance of contact, reduces the heat, and prevents sparking.

Those who are interested in this machine, and everyone should be, for it is a decided step in advance, will soon have an opportunity of seeing it at work at 57, High Holborn.

There was a very interesting form of Gramme machine shown, which was maintained at a velocity of 2,400 revolutions per minute, and was said to generate an electromotive force of 2,000 volts. It maintained 60 Jamin candles alight. But one of the best and most compact forms of Gramme was that shown by the British Electric Light Company, designed by their engineer, and made for them by Messrs. Emerson, in Stockport.

The display of lamps was the display of the building. There were very few novelties among arc lamps. An arc lamp consists of two sticks, or rods of carbon, which are kept apart by a small fraction of an inch while the current flows through them, but which come together when the current ceases. Across the interval separating them there is a steady flow of electricity, accompanied by a slow consumption of the carbon of each rod. This flow of electricity produces high temperature, and intense incandescence and combustion of the carbon particles. This is the arc. One lamp differs from another only in the way in which the carbons are moved forward as they consume, so as to maintain the resistance equal and the light steady. Among arc lamps, that which singled itself out among all its compeers, for steadiness and brilliancy, was the Jasper lamp, exhibited in the Belgian Section; but it had the disadvantage of absorbing all the energy of one machine.

(TO BE CONTINUED.)

* A paper read before the Society of Arts on Wednesday, December 14.

* The largest Brush machine weighs two tons, and absorbs 40 horse-power.

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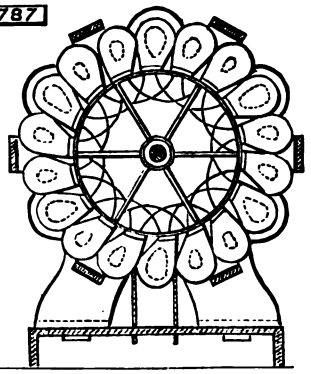
RECENT INVENTIONS.

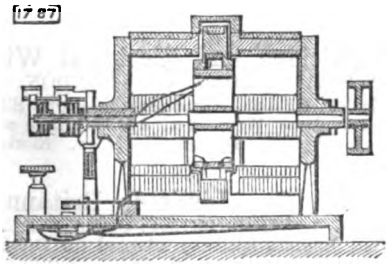
ABSTRACTS OF SPECIFICATIONS.

1787. IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINES, *A. M. Clark.*—*25th April*, 1881.—(*A communication from H. J. Muller and A. Levett.*) 1s. 4d.

The object of the invention is to provide an improved dynamo machine for various purposes, but more particularly for use in electro-plating. The armature wheel is provided with broad flat spokes, and with openings in the periphery to create an



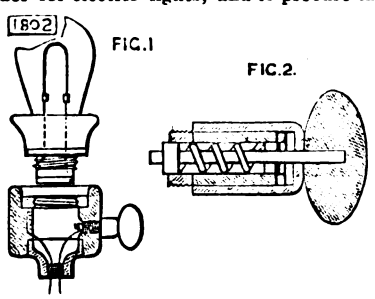
air current and provide against heating of the coils. The invention also consists in a relay and resistance combined with the machine, whereby the secondary current from the bath of plating solution is made to pass through the magnets in the same direction as the main current, the relay also regulating the permanent charge of the machine. A series of switches are provided in combination with the external circuits and the circuits



of the armature coils, whereby any one external circuit can be altogether shut off to permit of operating the machine with less motive power. The inventor claims to have prevented sparking at the commutator by arranging the armature coils so as to overlap the field magnets. Fig. 1 is a longitudinal sectional elevation of the machine; and Fig. 2 a cross sectional elevation.

1802. IMPROVEMENTS IN ELECTRIC LIGHT AND FITTINGS, &C., THEREFOR, *P. Jensen.*—*26th April*, 1881.—(*A communication from T. A. Edison.*) 10d.

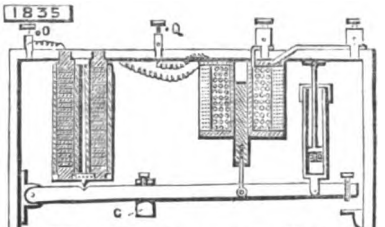
The object of this invention is to provide a safe holder for electric lights, and to procure this by



other means than friction between the neck of the lamp and the socket of the holder. It is an improvement on Patent No. 578, dated 10th February, 1880. This object is accomplished thus:—Secured to the glass neck of the lamp is a second neck, made of insulating material, upon the exterior of which are fastened two metal bands, one clamp of the conductor being connected electrically to one band, and the other clamp to the other band; one of the bands is formed with a male screw thread. The socket is also made of insulating material hollowed out to receive the neck from one end, and formed with a screw thread at the other, by which it is attached to any ordinary gas fixture. The socket is provided with a circuit controller, as shown, which is seated in the wall of the socket, and forms the socket terminal of one of the conductors leading thereto. The part fixed in the socket is screw-threaded, and is partially hollow. Through it passes a rod carrying the contact point in its inner end, and terminating outside in an insulated thumb-piece. The outer head has two grooves extending across the diameter at right angles, one deeper than the other. These have bevelled sides, so that a pin secured to the rod above-mentioned may be easily forced therefrom by force applied to the thumb-piece. A washer takes against a spiral spring on the rod, so as to force the latter in. When the rod is turned by the thumb-piece, so that the pin takes in the deeper indentation, the spring forces the rod inward sufficiently to close the circuit, while when the pin takes in the shallower the circuit remains open. Fig. 1 shows the mode of fixing the lamp in socket, and Fig. 2 gives a section of the circuit controller. Other methods of hanging electric lamps are also described.

1835. IMPROVEMENTS IN CURRENT GOVERNORS FOR DYNAMO-ELECTRIC MACHINES, *H. J. Haddan.*—*28th April*, 1881.—(*A communication from C. F. Brush.*) 6d.

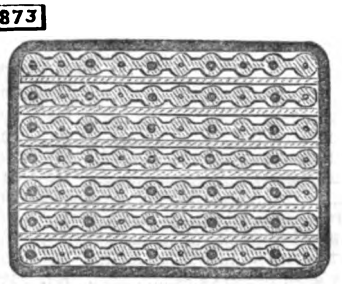
This invention is intended to adapt dynamo-electric machines to variable external conditions without variation in the speed of rotation of their armatures, and is an improvement on previous patents. The binding posts O Q form the terminals of the shunt circuit, and are connected with the dynamo machine. The shunt current passes from O to the piles of carbon as shown, these are enclosed in glass, and rest upon blocks of carbon electrically connected and carried by a bar of wood, pivotted to and supported by the lever; the shunt current then passes through the outer portion of the helix to the post Q. The right-hand posts are put in the working circuit of the machine, but in such a manner that the main current passes through its half of the helix in the same direction as the shunt current. Weight C is so adjusted that when the machine is working to its full capacity, and the working current is passing through its half of the helix, the enclosed iron core, lifted by the axial magnetism developed in the helix, just sustains the lever and parts con.



nected, while subjecting the piles H to no pressure. If the resistance of the working circuit be lessened the current in the helix is increased, the core drawn upwards, raising the lever and subjecting the carbon piles to a pressure corresponding to the increase of current in main circuit. The current will then be shunted from the field magnets of the machine until the main current is reduced to its original strength. A dash pot is shown at the right hand side of the figure, filled with glycerine and fitted with a piston which retards the upward motion of lever, its downward motion can be regulated by the screw shown. The dash pot is also fitted with a valve as shown, which causes the lever at once to drop should the main circuit be broken, and the shunt resistance is also increased at the same time, thus allowing the machine to exert its full power to separate the carbons in the lamps in the main circuit, when they have come together and completed the circuit again.

1873. IMPROVEMENTS IN TELEGRAPH CABLES, &C., *W. T. Henley.*—*30th April*, 1881. 6d.

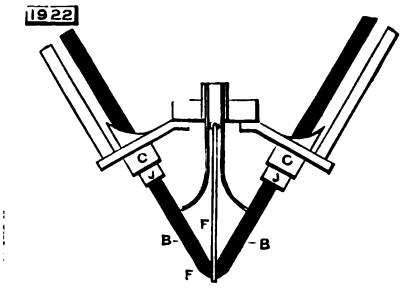
The object of this invention is to produce cables of additional strength, whilst obviating the effects of induction. The inventor insulates the wires with "ozokerited" india rubber, and encloses them by means of rollers or dies in the insulating material. For telephonic purposes he constructs the cable so as to obtain a metallic circuit, and makes one wire of each pair of steel, galvanised or coated with zinc; the copper wire of the pair being as much smaller than the steel one as is necessary to make their resistances about equal. The figure shows several pairs superposed, with tarred felt between the layers. This cable may



be laid in a trough or suspended. Several modifications of the method of combining the wires into a cable are also described and illustrated.

1922. IMPROVED CONSTRUCTION OF ELECTRIC LAMP, *J. B. Rogers.*—*3rd May*, 1881. 6d.

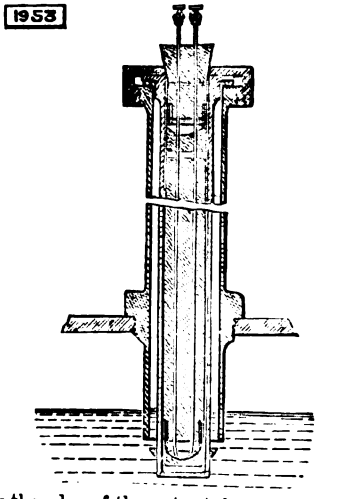
This relates to what may be termed a gravity lamp, the carbons resting in guides and fall by their own weight, impinging against incombus-



tible material as shown in the figure. B B show carbons, C J the guides, and F the asbestos or other incombustible material.

1953. AN APPARATUS FOR CONTROLLING THE LOWEST HEIGHT OF WATER LEVEL, AND THE MAXIMUM TEMPERATURE IN STEAM BOILERS BY THE MEDIUM OF ELECTRICITY, *C. Pieper.*—*5th May*, 1881.—(*A communication from R. Schwartzkopff.*) 8d.

This apparatus consists of two tubes, the one fitting in the other as shown. The centre tube is provided with two wires insulated from one another. At both ends of the tube are porcelain cups through which the wires run, and rings of easily fusible metal, as shown in section in the figure. The wires are connected externally to an alarum and battery. When the water level sinks



below the edge of the outer tube, steam will enter the space between it and the inner one, and by its heat melt the upper ring of fusible metal, which will run into the porcelain cup and make contact between the wires. When, on the other hand, the steam pressure, and, therefore, water temperature becomes excessive, the lower ring will be melted and produce the same results. This apparatus is fixed into the side of the boiler, leaving about 4ft. projecting to keep it cool.

1950. IMPROVEMENTS IN TELEPHONIC APPARATUS, *W. R. Lake*—*4th May*, 1881.—(*A communication from L. Maiche.*) 6d.

This invention applies to microphonic apparatus with a separate vibrating plate or disc for each contact piece.

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COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Dec. 14.		Business Done Week Ending Dec. 14. Highest.	Lowest.
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Do. Preferred	79½,	80½	81¼	80½
Do. Deferred	22½,	22¾	23¼	22¾
Brazil Submarine	11,	11¼	—	—
Cuba	9½,	10	—	—
Do. Preference	16,	17	—	—
Direct Spanish	4¼,	5	4¾	4¾
Do. Preference	14,	15	14¾	14¾
Direct United States Cable	10¾,	10⅝	10⅝	10⅜
Eastern Telegraph	10,	10¼	10¼	10
Do. 6 per Cent. Preference	12¾,	12¾	12¾	12¾
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	10¾,	11¼	11¼	10¾
German Union	10,	10¼	—	—
Globe Telegraph and Trust Company.	6¼,	6¾	6¾	6¾
Do. Preference	12¾,	12¾	12¾	12¾
Great Northern	12¼,	12¾	12¾	12¾
Indo-European	27½,	28½	—	—
Mediterranean Extension	2¼,	2¾	—	—
Do. Preference	9¼,	10	—	—
Reuter's	12,	12½	—	—
Submarine	290,	300	292	292
West India and Panama	1¼,	1¾	1¾	1 11-16
Do. 1st Preference	7½,	8	7¾	7¾
Western Brazilian	7¾,	7¾	7 9-16	7 7-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

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Oriental	¼,	½	½	5-16
United Telephone	10¾,	10⅝	10¾	9¾

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Electric Light and Power	1¼,	1¾	1¾	1¾
Anglo-American Brush	9,	9½	9½	9

TRAFFIC RECEIPTS FOR NOVEMBER, 1881.

Companies.	Nov., 1881.	Nov., 1880.	Increse.	Decres.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	£2,600	£1,960	£640	—
Direct Spanish Telegraph Company	1,810	1,465	345	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,557	29,724	2,833	—
Eastern Telegraph Company	49,829	45,669	4,160	—
Great Northern Telegraph Company	17,120	—	—	—
Submarine Telegraph Company	—	—	—	—
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West Coast of America Telegraph Company	—	—	—	—
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3. MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.
4. CABLES, WIRES, LIGHTNING CONDUCTORS.
5. APPARATUS FOR MEASURING ELECTRICITY.
6. TELEGRAPHS AND SIGNALS.
7. TELEPHONES, MICROPHONES, PHOTOPHONES.
8. ELECTRIC LIGHTING.
9. ELECTRIC MOTOR POWER.
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11. ELECTRO-CHEMISTRY.
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Crompton, R. E.
Edison, T. A.
Electric Light and Power Generator Company.
Electric Light Engineering Company.
Electric Lighting Supply Company.
Electric Light Carbon Company.
Elmore W.
Gerard, A.
Graham, D. H.
Gravier and Co.
Hammond and Co.
Hawkes (G.) and Co.
Henley, W. T.
Macdonald, J. Kay Athole.
Mignon et Rouart.
Rowatt and Fyfe.
Scientific Toy Company.
Siemens Brothers and Co.
Siemens Frères.
Somzée, M. Leon.
Swan Electric Light Company (Limited).
Strode and Co.
Thomas, Evan.
Varley (S. A.) and Co.
Werdermann, R.
White House Mills Company.

Announcements of other allotments will be made from time to time.

COMPAGNIE FRANÇAISE DU TÉLÉGRAPHE DE PARIS À NEW YORK.

REDUCTION OF TARIFF.

On and after 1st August, 1881, the rate for the transmission of Telegrams from the United Kingdom to NEW YORK and CANADA will be

1/- per word.

The name of the place from which Messages originate will be transmitted free of charge.

Rates to other places and further particulars may be obtained at the following Offices of the Company:—

Open Day and Night.

LONDON: 24, ROYAL EXCHANGE, E.C.
LIVERPOOL: H5, EXCHANGE BUILDINGS.
NEW YORK: 135, BROADWAY, and Corner of Exchange Place and Broad Street

The Public are recommended to hand in their Messages at the Company's Stations, as above, where receipts are given for the amounts charged.

Messages for this Company's Cables will be received at any of the Postal Telegraph Stations throughout the United Kingdom. Attention, however, is called to the IMPORTANCE of SENDERS WRITING DOWN on the FORMS for AMERICAN MESSAGES, which are specially provided at Post Office Telegraph Stations, the indication,

"Via FRENCH" or "Via PQ."

This is signalled as an official instruction, and not charged for.

Books of this Company's Message Forms and further information can be obtained on application to

24, ROYAL EXCHANGE, LONDON, E.C., & H5, EXCHANGE BUILDINGS, LIVERPOOL.

THE SCHOOL OF SUBMARINE TELEGRAPHY & OF TELEPHONY.

ESTABLISHED IN 1868.

4, GEORGE STREET, HANOVER SQUARE, LONDON, W.

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of the various systems of working in general use, the following subjects:—

MATHEMATICS, MECHANICS, and CHEMISTRY, (In relation to Telegraphy.)

SIGNALLING and TESTING INSTRUMENTS.

ENGINEERING FORMULÆ and their Application in Practice.

ELECTRO-STATICS.

ELECTRO-DYNAMICS.

MAGNETISM.

METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction.

TESTING FOR and LOCALISING FAULTS, &c., &c., &c.

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A Course of Instruction in the Fitting up, working, and Testing of TELEPHONE CIRCUITS has now been added to, and embodied in, the ordinary curriculum, including all the forms of TELEPHONES, the various switch board arrangements and EXCHANGE SYSTEMS in general use.

Further information can be obtained on application to the SECRETARY.

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS,

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

NEWALL'S PATENT LIGHTNING CONDUCTORS.

Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

NEWALL & CO.'S PATENT COPPER-ROPE LIGHTNING CONDUCTOR,

As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public. It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

SOLE PATENTEES OF UNTWISTED WIRE ROPE.

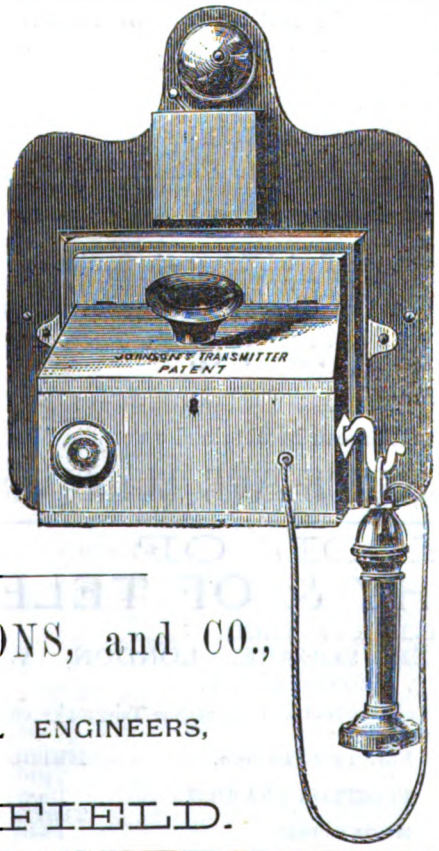
Manufacturers of Iron and Steel Ropes for Colliery and Railway purposes. Rigging Ropes, Guide Ropes, &c.

Gilt and Silver Cord for Hanging Pictures. Iron, Steel, and Copper Cord for Clock and Sash Lines, &c.

R. S. NEWALL & CO., LONDON, 130, STRAND, W.C.

LIVERPOOL—36, Waterloo Road. GLASGOW—68, Anderston Quay. Manufactory—GATESHEAD-ON-TYNE.

JOHNSON'S PATENT TRANSMITTER.



BELL'S PATENT TELEPHONE.

The best combination for Exchange and Private Lines.

TASKER, SONS, and CO.,

ELECTRICAL ENGINEERS,

SHEFFIELD.

ESTABLISHED 1851.

BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane

VULCANITE.

HARBURG INDIA-RUBBER COMB COMPANY.

LONDON WAREHOUSE: F. WINTER.

138, LONDON WALL, WOOD ST., E.C.

EBONITE.

HARBOROW & CO.,

ELECTRIC LIGHT ENGINEERS

AND

TELEGRAPH INSTRUMENT MANUFACTURERS,

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A WELL-KNOWN firm of Telegraph Engineers in the West of England having an extensive business is prepared to TAKE a LIMITED NUMBER of PUPILS. Exceptional opportunities offered for becoming thoroughly acquainted with the construction and maintenance of Telegraphs. Particulars may be had by addressing "ELECTRICIAN," care of Messrs. KING BURY and Co., Lombard House, George-yard, E.C.

Just published, Crown 8vo., cloth, 12s. 6d.

A HANDBOOK of ELECTRICAL TESTING. By H. R. KEMPE, Member of the Society of Telegraph Engineers, Assoc. Mem. Inst. C.E. Second Edition, Revised and Enlarged.

London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street

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SLIP

S.S. "Dacia."—This cable ship arrived at Rio Janeiro, on Monday, the 19th inst, "all well."

Cable Repaired.—The cable of the Paris-New York Telegraph Company has been repaired.

Electric Light in Collieries.—Tenders have been invited for supplying electric light to Houghton Colliery.

United States Signal Service.—The total number of stations belonging to this service now open is given as 296.

Dividend.—The Great Northern Telegraph Company announce a half-yearly interim dividend at the rate of 5 per cent. per annum.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended the 16th instant amounted to £3,899.

Electric Light in Ironworks.—The electric light is now in use at the Rhymney Rolling Mill, in Wales, and its utility is highly spoken of.

Tunis.—According to telegraphic advices a violent hurricane, which took place at the end of last week, had broken many of the telegraph wires.

New Edison Company.—The Edison Company for Isolated Lighting, with a capital of 500,000 dollars, has filed articles of incorporation in Albany, New York.

Oriental Telephone Company.—There will be a meeting of the shareholders of this Company at the Cannon-street Hotel on Wednesday next, the 28th December.

Brighton Sanitary Exhibition.—On Wednesday the awards and medals were distributed to exhibitors. Amongst the recipients were the Brush Electric Light Company, who obtained a silver medal.

The Brush Light in Iron Works.—We hear that the Brush Electric Light Company have received orders to supply the Moss Bay Steel Works, and also the West Cumberland Works, with their light.

Electric Light at Hanley (Staffs.).—It is stated that the Corporation of Hanley are about to make an experimental trial of the electric light in some of the large open places in the centre of the town.

Eastern Extension Telegraph Company.—This company notify that the coupon, due January 1, on their Five per Cent. Australian Government Subsidy Debentures will be paid on and after January 2 on presentation at Messrs. Barclay's bank.

Globe Telegraph and Trust Company.—The directors of this company have declared interim dividends for the quarter ending Jan. 18, 1882, of 3s. per share on the preference and of 1s. 6d. per share on the ordinary shares, both free of income-tax.

Electric Lighting for Winchester.—The Town Council are inviting suggestions from electric light companies for lighting the streets by electricity. Particulars should be sent to Mr. Walter Bailey, town clerk, Guildhall, Winchester, by the 14th of January.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending 16th December, 1881, were £2,442, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Eastern Telegraph Company.—This company announce the proposed payment of a dividend of 3s. per share on the Six per Cent. Preference Shares for the quarter ended December 31, and an interim dividend of 2s. 6d. per share on the ordinary shares.

The Telephone in Liverpool.—A telephone experiment between the Philharmonic Hall and the office of the chairman of directors—a mile distant—was tried on Tuesday, on the occasion of a concert rehearsal, and found satisfactory, both instruments and voices being heard.

Electric Light for Clerkenwell.—At a recent meeting of the Vestry of Clerkenwell a resolution was adopted to the effect that the Works Committee should try and make arrangements with some of the electric light companies for the introduction of the light into the parish.

The Telegraph in the Transvaal.—The *Cape Argus* says that the closing of the telegraph offices at Pretoria, Heidelberg, and Standerton, in the Transvaal, is due to the inability of the Transvaal Executive to obtain operators now that the Royal Engineers have left the country.

S.S. "International."—The "International," belonging to the India Rubber, Gutta Percha, and Telegraph Works Company, arrived safely at Vera Cruz on Saturday last, the 17th, "all well." She has the Vera Cruz-Goatza-Coalcos section of the Central and South American Company's cable on board.

Electric Lighting at the Royal Society.—For some time past the society has been in the habit of occasionally illuminating its rooms on the nights of meetings with Swan lamps. We now hear that it has definitely adopted this system for the meeting room and approaches. The lamps are driven by a Siemens machine.

Electric Light for Derby.—There is some probability that the Brush light will, ere long, be introduced into Derby. The Town Council do not seem inclined to adopt it on a large scale, but are understood to offer no objection to its being used in the market hall, market place, and some of the principal streets, at the expense of the company introducing it.

An Electrical Christmas Tree.—A large Christmas tree, hung with incandescent electric lights, will make a very pretty effect, and we understand that the Edison Agency in London, acting on a suggestion of Mr. J. Munro, intend to have one at the forthcoming Crystal Palace Exhibition. The usual giant tree will not this year be erected, as the space is taken for the Exhibition.

Electric Light at Barnsley.—It is said that the inhabitants of Barnsley are so pleased with the Brush lamps erected by Messrs. Hammond and Co. that a requisition has been numerously signed and presented to the Mayor asking him to call a special meeting of the Town Council to consider the matter, and requesting that the town may be lighted by these lamps until after Christmas.

Great Northern Telegraph Company.—The company's cables between Amoy-Shanghai and between Amoy-Hong Kong are interrupted, thus isolating Amoy both from the north and south. Telegrams for Hong Kong cannot, therefore, be forwarded by this company's route, while telegrams for Amoy are forwarded by post from Shanghai. Until the restoration of the interrupted sections the company's line is the only available route to Shanghai and Japan.

More Sermons by Telephone.—On Sunday last special services for the convenience of the visitors to the Sanitary Exhibition, now being held at Brighton, were held in the Dome. A transmitter was placed in the pulpit in front of the preacher, and connected with a telephone receiver at the Police Station, some half a mile away, and also with another receiver placed in the King's Apartment at the Royal Pavi-

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lion. It is stated that not only the sermon but the whole service could be distinctly heard at both places.

Opening of New Telegraph Stations in China.—The telegraph land line from Shanghai to Tientsin having been completed, the Great Northern Telegraph Company give notice that they will, on and after the 24th inst., be prepared to accept messages for Soochow, Chinkiang and Tientsin. In addition to the ordinary rate for Shanghai (8s. 4d. per word) the following land line rates will be charged:—For Soochow 10d., Chinkiang 11d., Tientsin 1s. 3d. per word. The minimum land line charge will be for seven words.

The Opera by Telephone in London.—On Wednesday the directors of the United Telephone Co. invited several ladies and gentlemen to a telephonic opera at the Bristol Hotel, in Burlington-gardens. The telephone wires were connected with the New Comedy Theatre, in Panton-street, Haymarket, where "La Mascotte," an *opera bouffe*, was being played, with Miss Violet Cameron and Mr. Lionel Brough in the chief parts. The performance was rendered perfectly audible at the hotel, and the visitors seem to have been greatly pleased.

The Eastern Extension Company.—We understand that the old Batavia-Singapore cable, which we noticed in our issue of the 3rd December last was successfully replaced by a cable of an improved design, has been taken up, without a hitch in the work. It is pleasant to record these successful operations with cables, as it is a positive proof to shareholders that their property is becoming more and more valuable, inasmuch as it is surrounded with less risk of absolute loss from the experience gained, and the appliances designed for repairing or replacing.

More Gales.—From Saturday last up to Tuesday night it blew very hard from the south-west, culminating at times in a furious gale. As a consequence, we hear on all sides of telegraph wires down. The gale was accompanied on Monday night by a heavy thunderstorm, with very vivid lightning. The wonder is that the wires stand these gales as they do; it says a great deal for the skill with which they are erected. We should, however, greatly prefer to see some of this skill directed to laying them under ground. Germany has shown us the way, France is following, America also. Are we to be the last?

The Scilly Cable.—The following letter has appeared in *The Times*:—"It will interest very much many of your readers, as well as the general public, to know that the steamer Morna arrived here yesterday from Dartmouth with Mr. Lumsden and staff on board to repair the broken telegraph cable, so that in all probability communication with the outside world will be restored to-day or to-morrow. We hope, before another break occurs, that the Post Office authorities will find means to repair in less than five months, the time which it has occupied on this occasion.—Yours very truly, Francis Banfield and Sons, Scilly, Dec. 11."

The Galvanic Battery and Shamming.—The other day a man at Brighton who had been charged with swindling, was unable to be brought before the magistrates owing to his exhibiting symptoms of hydrophobia. He was accordingly sent to the hospital. After examination by the doctor, a galvanic battery was made use of, but without seeming to produce much effect. Upon the doctor remarking, however, that he would obtain a far stronger battery and try that, the man suddenly ceased his barking, and all symptoms of hydrophobia disappeared. He subsequently confessed that he had been shamming, and is now hard at work—in prison.

Honours for Electricians.—On the proposition of M. Cochery, Minister of Posts and Telegraphs, the Minister of Foreign Affairs and President of Council has nominated Dr. Warren De La Rue, F.R.S., correspondent of the French Institute, Commander of the Legion of Honour, in recognition of his services at the Electrical Congress and as vice-president of the jury. In addition to the above decoration, Professor Hughes, F.R.S., and, we believe, all the English Commissioners, have been made Knight Commanders of the Legion of Honour. Mr. W. H. Preece, F.R.S., and Mr. E. Graves, of the Post Office, have also received the rank of Chevalier and Officer respectively of the Legion.

The Electric Light at Godalming.—Messrs. Calder and Barrett have introduced seven of Siemens's arc lamps and several of Swan's incandescent lamps into Godalming, the whole of which were lit up last week as a trial. The motive power is obtained by two turbine wheels in combination with a semi-portable steam engine by Wallis and Stevens, of Basingstoke. Siemens's dynamo machines are used to generate the current. The same firm have introduced the electric light, arc and incandescent, into Messrs. Pulman's Leather Mills, where the turbines and engines are placed. It is also probable that the library, theatre, and approach to Charterhouse Schools will shortly be supplied with Swan lamps fed from the same source.

The Direct Spanish Cable.—The Silvertown Company has been particularly fortunate in the repairs of this cable. The ss. "Œrsted" left Greenhithe last Sunday, Dec. 11th, at 3 a.m., in order to repair the Lizard-Bilbao cable. Grappling was commenced immediately on reaching Bilbao on the evening of the following Wednesday, Dec. 14th. The cable was hooked at the first drag, and the Lizard end buoyed. The inshore end was hooked the following morning, Dec. 15th, and the cable repairs completed at half-past 4 on that day, Thursday. The "Œrsted" had some 700 miles to steam before commencing work, and as the repairs were effected in little more than four days we may reckon this achievement amongst those placed at the head of the list of cable-work performances. Mr. H. Benest was in charge of the work, and it is needless to point out that he is entitled to great credit for such a successful operation.

Society of Telegraph Engineers and Electricians.—At the annual general meeting of the Society of Telegraph Engineers and of Electricians, held at the Institution of Civil Engineers, 25, Great George-street, on Thursday evening, the 15th inst. (a report of which appears in another column), the following gentlemen were elected as the Council of the Society for the ensuing year, viz.:—President: Lieut.-Col. C. E. Webber, R.E. Vice-Presidents: Willoughby Smith, Professor W. G. Adams, F.R.S.; C. E. Spagnoletti, M. Inst. C.E.; Professor D. E. Hughes, F.R.S. Hon. Treasurer: E. Graves. Hon. Secretary: Lieut.-Col. Frank Bolton. Council: W. S. Andrews, William T. Ansell, Sir Charles Bright, M. Inst. C.E.; E. B. Bright, the Earl of Crawford and Balcarres, F.R.S.; H. G. Erichson, H. C. Forde, M. Inst. C.E.; Matthew Gray, John Fletcher Moulton, F.R.S.; Alexander Siemens, Augustus Stroh, C. F. Varley, F.R.S. Associate Members of Council: Capt. J. T. Bucknill, R.E.; C. H. B. Patey, T. R. Crampton, M. Inst. C.E.

Secondary Batteries.—M. Planté has found that his secondary batteries accumulate electricity much more quickly if the lead plates be heated before the couple is formed, or if the current used to form the couples be strong enough to warm the liquid. The most convenient temperature is found to be from 70 to 80 degrees, but in a general way it may be said to vary between 20 degrees and the point of ebullition

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of the acidulated water. The couples may be submitted to this elevation of temperature in any convenient form. Plates of lead, not made up into couples, can be first oxydised, and then heated by a current, and the couples formed afterwards. The effect of this elevation of temperature is to dilate the molecular pores of the metal plates, and to thus facilitate the penetrating action of the electrolyte. It also aids, owing to the subsequent cooling process, the collection of crystals of peroxide of lead and reduced lead, which is favourable to the production of the secondary current and the retention of the charge. The time occupied in the formation of the Planté cell is thus greatly reduced.

"Wonders of Electricity."—This is a little book by Ascott R. Hope, published by Gall and Inglis, intended to interest the young in a science which, though really in its infancy, has already given to the world startling proofs of the aid which civilisation may ultimately expect from its development. Although the name of the author may not be recognised by pure scientists, those who have studied the literature supplied for the young will know the writer as one of the most painstaking as well as one of the most eminent in a field he has made peculiarly his own. Among the authors who write for young people, there is not one whose works are freer from twaddle, from the startling and tragic scenes, upon the depiction of which so many penny dreadfuls depend for obtaining a *clientele*. Purity of tone, and a high standard of literary excellence, can be credited to this author. The thoroughness of his work in these directions naturally leads us to look with some excess of zeal to find the failures in the scientific harness of the author, but we must confess that great care has been taken so to write this little book that the reader, when he comes to read more and more advanced treatises, may not have anything to unlearn. In six chapters the author has collected a number of historical notes, referring to the early methods of transmitting intelligence, the early discoveries in static and dynamic electricity, as well as descriptive accounts of those later electrical discoveries which have done so much to astonish and awe even those whose life has been devoted to the study of the subject. The whole is written in a clear and simple manner, quite within the range of understanding of the beginner, and we know of no book better suited for a "Christmax box" to the youth wishing to obtain an inkling of the "Wonders of Electricity" than the one before us.

German Union Telegraph Company.—It has been resolved to increase the authorised capital of this company by the issue of 11,000 shares of 300 marks, or £15 sterling, each, bearing a preferential dividend of 5½ per cent., amounting on the whole to 3,300,000 marks, or £165,000 sterling, for the purpose of establishing direct telegraphic communication between North Germany and the United States of America, by means of an underground cable from Emden to Greetsiel, and a submarine cable between Greetsiel, in East Friesland, and Valentia, Ireland, at which place it will be connected with a transatlantic cable already in existence. This cable will be laid by an English firm. The dividend upon the new preference shares will begin on the 1st January, 1882, and will be cumulative. The first subscribers, or their successors, who determine to exercise their right of taking one new preference share at par in respect of every two shares originally subscribed for, must make a written application to the direction of the company, 4, Werderstrasse, Berlin, when they will receive a certificate prepared upon the basis of the list of subscribers, and containing the number of preference shares to which they are entitled at par. The existing proprietors, for the time being, who desire to exercise their privilege of taking one new preference share in respect of every two original shares held by them, must deposit their share certificates, without the dividend coupons attached, together with a duplicate list containing the number of the shares, drawn up in proper running order, and duly signed, either at the offices of the company, No. 4, Werderstrasse, Berlin, or to the agents of the company, at No. 66, Old Broad-street, London. The original shares will then be stamped, and a certificate issued by the direction containing the number of preference shares to which the applicant is entitled. The certificates issued by the direction must be presented within the prescribed period, ending on the 20th of January, at the banking house of Messrs. Emile Erlanger and Co., 43, Lothbury, London, where they will be exchanged for the proper number of preference shares to which the parties presenting them are entitled upon payment of the sum of £15 sterling in respect of each share subscribed for. After the expiration of the prescribed period of four weeks, within which all applications must be made, all rights to the new preference shares become absolutely extinct.

Submarine Cables.—On another page we print a copy of a memorial which has been presented to Lord Granville on behalf of the telegraph companies, setting forth the difficulties they have to contend with when repairing their cables, and asking for some protection in the matter. The subject has been brought prominently before the public lately by a long correspondence in *The Times*, which has been reproduced in these columns. That journal makes some comments on the memorial which are worth reproducing. It says:—"In view of the provocations given," by fishermen and others, "and the extensive damage suffered over and over again, the language of the memorial to Lord Granville is singularly calm and moderate. The companies ask, as they have a right to ask, for protection." As to how they are to be protected, *The Times* continues:—"The possible remedies may be divided under two headings. There are those which our own Government can enforce, and those which can only come from a general agreement, to which other Governments must be parties. Of the first kind are the additions to our own statute law, which would make wilful or grossly careless damage to submarine cables a penal offence. But far more important than anything which the English Government can do would be the effect of an international arrangement for the legal protection of submarine cables. It is, therefore, much to be desired that the needful protective legislation should be taken up as a common work by all countries. Germany, as an extract from a communication from the Minister of Posts and Telegraphs shows, is bestirring herself with a view to this. England, which has a larger stake than Germany, ought not to be less forward." The article concludes by referring to the question of the lights of telegraph ships and their having to pay harbour dues, concerning which we must refer our readers to the memorial, and also to a letter from Sir J. Anderson in *The Electrician* of Nov. 19, page 9. The communication from the German Minister of Posts and Telegraphs referred to above, reads as follows:—"I have already entered into communication with the proper functionaries of the German Empire with the view to bring about for submarine cables the legal protection urgently required in the direction of international provision and the alteration of our internal German penal code. Stephan." France is also stirring in the matter. It is stated that M. Cochery, the French Minister of Posts and Telegraphs, is preparing a project for the protection of cables, which is to be laid before the French Chamber of Deputies at an early date.

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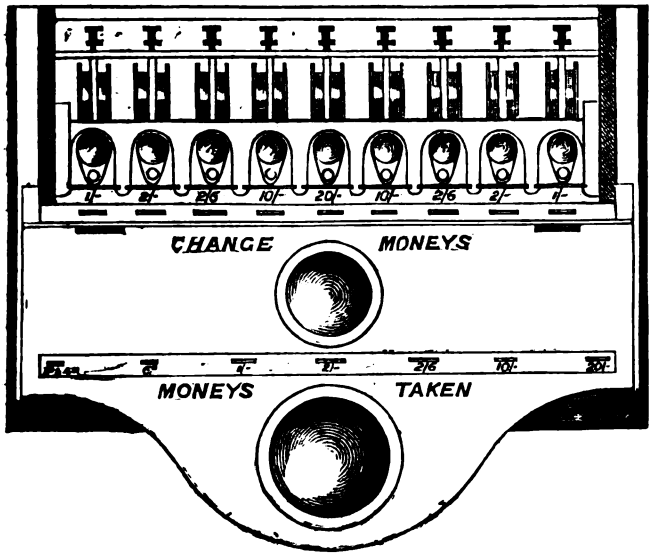
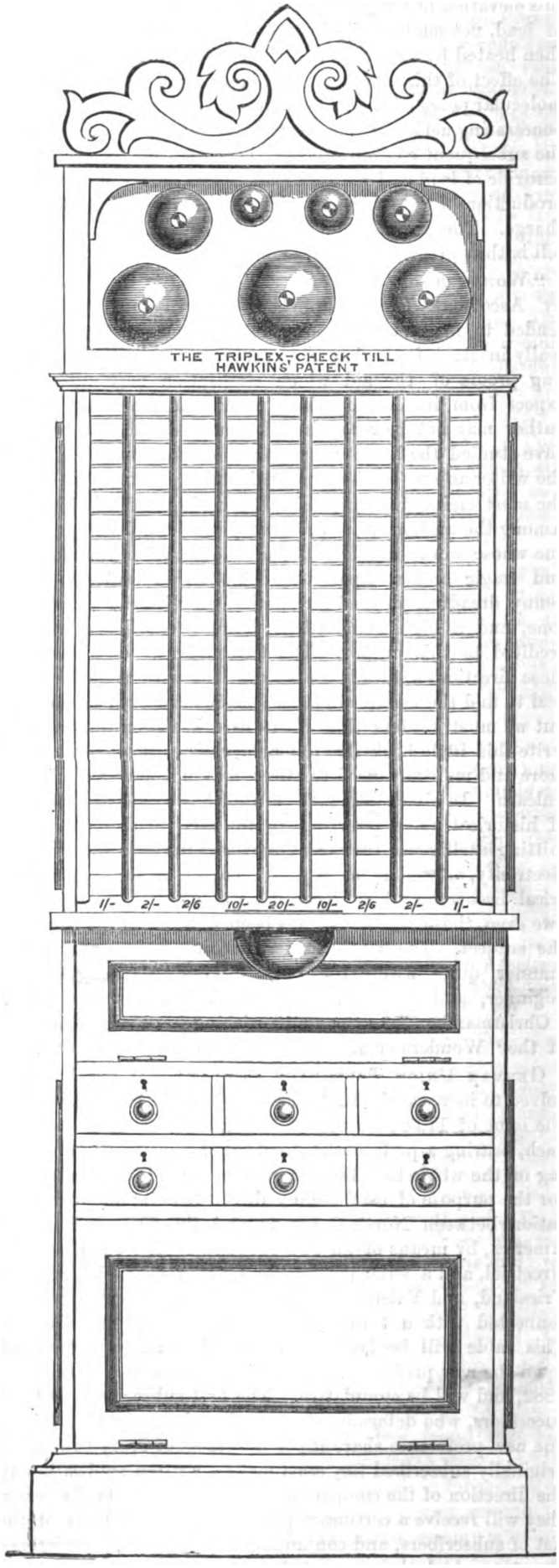
HAWKINS'S PATENT TRIPLEX CHECK TILL.

The accompanying illustrations show a front elevation of the till, and also a plan of the table, with its corresponding slits for the reception of the coins of the respective values as shown. Each of these slits corresponds to the exact size, both in diameter and width, of the coin for which an equivalent in change is required. Under each slit is a small drawer for receiving the denominational coin. This drawer is secured with a lock, and cannot be opened without ringing an electric bell, which may be at a distance, and unheard by the operator. This gives the till the character of a safe, for all the electrical arrangements are contained within it, and no drawer or door can be opened without producing an alarm, which of course can be conveyed wherever it is desired, besides which much time is saved in obtaining change. The whole arrangement forms a handsome cabinet which occupies a space of twenty-two inches by fifteen inches, and is about five feet in height. On the table of the till is a bowl or receptacle for pence, and which in fact contains the only money exposed. As shown in the diagram, this table has two sets of slits, which enable two persons to obtain change at the same time. Another set of slits admit separately all the coins, from a threepenny-piece to half-a-crown in silver, and sovereign and half-sovereign, representing moneys taken. The front elevation shows the shelves and divisions for containing the equivalents of each



coin *admissible* into their respective slits. The vertical rows are each divided into twenty separate compartments, and each compartment contains a small movable brass box, in which is the change for the coin deposited in the slit. In front of each row, vertically, is a separate glass slide or shutter, which, when pushed to the top, becomes fixed, and movable only by dropping in the coin corresponding in value to the change required, the shutter dropping through the space of one shelf for each coin passed through the slit. The brass box in which the value of the coin is placed can now be removed. As each shutter is worked by a separate and independent arrangement, the remaining rows and shelves are left protected. An important security against giving wrong change, which so frequently results in unpleasant disputes, is one of the principal advantages of the till. Suppose a coin, say a shilling, is dropped either intentionally or by mistake into the slit intended for the reception of a larger coin, it will simply pass through into the locked drawer under the slit, without actuating the mechanism which causes the shutter to drop. This constitutes an important safeguard against any fraudulent action on the part of a person using the till, for the coin becomes to all intents and purposes lost, until the person authorised to open the drawers is aquainted with the fact. Mistakes frequently happen through carelessness on the part of an assistant, without any fraudulent intention, so that it also, by the same result, informs an employer of the character of any individual assistant. A mistake in the other direction, by giving less change than is required, is rendered absolutely impossible,



for although a coin of lesser value can pass through the large

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slits, a coin of greater value cannot pass through the slits intended for the reception of coins of a lesser value.

We will suppose that the till is supplied with the necessary change the previous night, ready for business on the following day. All that is necessary is to count into each box the change corresponding to the value of the coin marked on the opposite slit. It is not necessary that all the recesses or shelves are filled, the cabinet, though constructed to hold the change for an aggregate value of £50, can, of course, be supplied with any smaller amount. In any case there is this very important check, both against fraud or carelessness, that whatever amount is supplied to the till on starting, the exact equivalent must be found either at the close of the day, or whenever the till is required to be "made up" again. As regards the takings, when a coin is dropped into its proper slit a bell is rung, and as each slit has a connection with a separate bell, giving a distinct tone and indication, it is possible to record the state of the till at any required distance from it.

Few people are aware of the great unpleasantness arising in large establishments where several assistants have access to the till. Frequently the till shows a smaller amount than is required by the sale books of the assistants, and it becomes impossible to fix the discrepancy on any individual. Not only will this till lead to the avoidance of attaching to a wrong party any irregularity, whether from carelessness or fraud, but as each assistant would have to give up at the close of the day the amounts corresponding to his entries, an employer will have less reason for anxiety, whilst the great check imposed on pilfering will, by removing temptation, be the means of saving many from a downward course in life, whose only fault may be, in many cases, the *one* impulse of a sudden temptation to abstract from a till a few shillings, or even a few pence.

We heartily wish every success to this important and ingenious invention of Mr. Hawkins. We see no reason why electricity should not be applied to the correction of social evils in this way. The prevention of crime is an important problem, and we must congratulate Mr. Hawkins on having introduced a method which is at once philanthropic and practical.

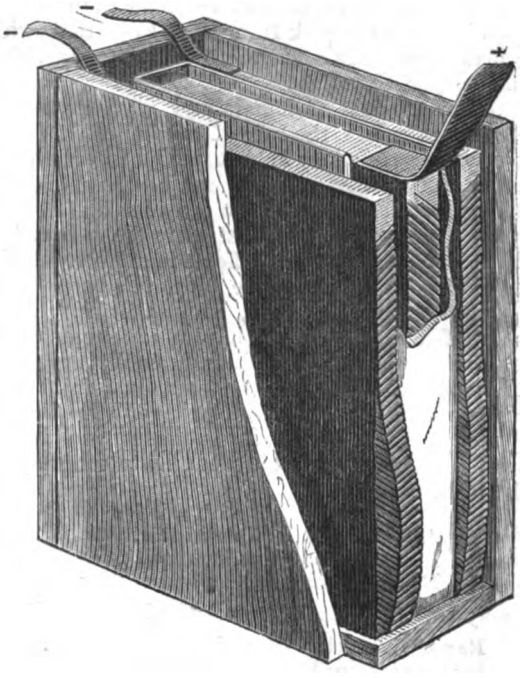
DE PEZZER'S MODIFICATION OF PLANTE'S BATTERY.

In a recent note (*Electrician*, Vol. VII., p. 227) we described a modification which had been introduced into the Planté cell by M. de Pezzer, by which he diminished the thickness of the negative plate whilst doubling its surface. He has lately, in conjunction with M. Carpentier, made still further improvements. He takes straight sheets of lead, about 10 to 15mm. wide, by 500mm. long, of a convenient thickness, and passes them between the rollers of an obliquely corrugating machine. Each sheet is folded in two, the parts being separated by a porous separator. The free ends are soldered together, and fringes are thus formed as shown in the figure. These fringes are introduced in place of the carbon and zinc, in a Bunsen cell, of the rectangular Rhumkorff kind; they fill up the porous jar and the intervals between the porous jar and the sides of the outer jar. The two jars are also filled with water and sulphuric acid. The soldered ends are at the top, the folds at the bottom; projecting plates fixed to the upper parts serve as electrodes, the positive in the interior, the negative outside. In this way the negative electrode has a surface double that of the positive.

The positive threads are ·5mm. thick, and 15 wide; the negative threads are ·25mm. thick and 10 wide. The waves of each thread make with its edges an angle of 45; after being folded, the inclination of the troughs is alternated on the two halves brought into contact. This arrangement maintains and limits the distance between neighbouring parts. The canals, whose existence is thus protected, assure the electrolytic action on all points, and their inclination guarantees the giving off of gases directly they begin to form.

MM. Pezzer and Carpentier construct their apparatus in troughs with two compartments. This arrangement is shown in the figure, but with four instead of two compartments.

Although the porous jar may seem to be inconvenient, the inventors have found that the resistance of their couple is not greater than that of other known accumulators. Moreover, there is a *raison d'être* for the porous jar. Secondary batteries in constant use are subject to crystallised junctions between the plates, which are a source of trouble. Felt, cloth, and amianthus prevent these junctions if they do not



encourage parasitic growths by furnishing them with a refuge, a development against which they are powerless. The walls of burnt earth act in a directly inverse manner; thus the partition causes to be retained on the plates, or in the field of their action, the particles of oxyde detached and carried off by gravity.

This arrangement of the secondary battery is said to have given good results.

FROM PARIS TO THE CRYSTAL PALACE.

So far as we are concerned, we shall follow the ordinary law of humanity, and look forward to the new comer instead of wasting breath over the old. We have, from time to time, described a few of the exhibits at Paris, and as many of those which neither time nor space has hitherto permitted us to describe will be transferred to the Crystal Palace, we shall continue the description of the apparatus at more length when the exhibition opens. More than thirty exhibitors have been allotted space at the Crystal Palace in the section devoted to electric lighting, and hence we may hope to see the wonderful effect produced at the Palais de l'Industrie at least equalled, if not surpassed. We know that strenuous efforts are being made in some quarters to render the exhibits still more complete than they were at Paris, and ere the month is run the spectator may see—

> Beneath yon peak, which on its brow
> Wears a star of brightest ray,
> That point whose light is filched even from the God of Day.

For in more than one sense the electric light is a kind of revivifying the long-since bottled-up light and heat rays from our great central luminary. We may in this transition period be permitted to transgress and wander a little from the narrow road which has to be followed in describing apparatus.

Those of us who have endeavoured to follow the progress of scientific thought during the last few years must often have spent an hour musing over the doctrine of the "Con-

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servation of Energy." It is one of the grand bulwarks of physical science. We have also read some of those brilliant essays on the "Dissipation of Energy," the "Cooling of the Earth," and the future of this globe. Such studies may by many be deemed uninteresting and unremunerative. Perhaps so. But, from an educational point of view, we have always looked upon these speculations into new regions as of great service in putting the greybeard of science and the younger thinker somewhat on the same footing. They stand at one point, and look forward into the great unknown. The eyes of the elder are here little better than those of his junior, and each may pick from the abyss that which will tend to make him more considerate for the ways, thoughts, and tendencies of the other.

Some of our greatest geologists and mathematicians have attempted to calculate the rate of cooling of this earth, and to state approximately how long it will be before the world is cold, dreary, and desolate. There are, however, factors in the calculation which have never been considered. For instance, has anyone ever attempted to estimate the "heat" that is annually taken from the sun's heat rays by vegetation and held in bondage? The coal we burn has been termed the result of bottled-up sunshine, and so it is. Our steam engines are fed with this bottled-up sunshine, and so our dynamo machines are revolved, and, finally, we get in the brilliant refulgence of the electric arc some faint return of the sunshine of the carboniferous age. To describe the "light" as it was seen at Paris, as it will be seen at Sydenham, is impossible. It is pleasant to contemplate that soon all will be able to

Behold with wonder
A proud palace rich and fair,
For whose lofty roofs the air
Bade the gold clouds part asunder.

They may realise that modern science has resuscitated the

Ray of light, that through the wind-swept
Plains of azure Heaven hath darted,

and go away contented with the assurance that what has been done is merely the outcome of investigation into the outskirts of a new field of usefulness. The hard and fast lines of science seldom allow us to enter the domain of the poet, and yet we doubt if any simple prose could frame a better invitation of the wonders of the forthcoming exhibition than will be found in Calderon's "Autos Sacramentalis":—

Verás mis grandes estudios,
Mis admirables portentos
Examinaras, locando
Dé mi Ciencia los efectos.
&c., &c., &c.

Of which the following is the translation by D. F. M'Carthy:—

Enter, then, my dazzling palace,
Where an intellectual banquet,
Graced by gladness and enjoyment
Waits upon thy welcome advent.
Thou will see my deep researches—
Thou my wonders wilt examine.
All the secrets of my science
Will be bared to give thee answer.
* * *
By a breath from out my lips
Thou wilt see the sunlight blackened.
* * *
Thou will read
As upon illumined parchment,
Written characters revealing
Nature's mysteries and marvels.

THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.*

(*Continued from page* 75.)

III.

In the circuit of a battery place a voltameter connected to it by a wire of known length. A certain quantity of gas will be disengaged in the voltameter per minute, and if we increase the length of wire the volume of gas evolved in the same time will diminish. The same result will ensue if we diminish the diameter of the wire; and the contrary effect will obtain if we increase the diameter of the wire, or shorten its length. The wire, in fact, acts as a resistance to the passage of the current, and there is a definite relation between the intensity of the current, the electromotive force, and the resistance of the circuit which was expressed by Ohm in the following law:—

$$(a) \quad \ldots\ldots\ldots \quad I = \frac{E}{R},$$

where I represents the intensity of the current, E the electromotive force of the battery, and R the total resistance of the circuit. We say total resistance, because it includes the resistance of the whole circuit connecting wires, apparatus, and battery. For resistances, as well as for chemical actions, the battery comes under the general law, and ought to count. Nevertheless, for the sake of simplicity in our explanation, we will neglect the internal resistance of the battery, and reckon only the external resistance.

(*b*) Ohm's law applies not only to a whole circuit, but to a part of one, and we can write

$$I = \frac{e}{r},$$

where I is the intensity, *e* the difference of potential between the two ends of a portion of the circuit (as M, N, Fig. 2), and *r* the resistance of that portion. Ohm's law has been verified by Pouillet, Fechner, Despretz, and is in daily use amongst electricians.

Oersted's discovery of the action of a current on a magnetic needle has supplied us with the galvanometer, an instrument far more convenient than the voltameter for measuring currents. The electromotive force, intensity, and resistance, are measured by standards or units devised by the British Association for the Advancement of Science, and recently adopted by the International Congress of Electricians at Paris.

The unit of tension or electromotive force is the volt, its value is about 0·95 of the electromotive force of a Daniell cell.

The unit of resistance is the ohm. It is represented by a column of mercury 1·05 metre high, and a square millimetre in section. It is approximately equivalent to 48 metres of copper wire 1 millimetre in diameter.

The unit of intensity has been named by the Congress the Ampère. It is an intensity of current capable of precipitating very nearly 4 grammes of silver per hour.*

According to Ohm's law, cited above, the unit of intensity $= \frac{\text{unit of electromotive force}}{\text{unit of resistance}}$.

IV.—*The Transport of Electrical Energy.*

After the prefatory definitions given in our last article, we will pass to the transport of chemical energy.

(*a*) In employing a voltaic battery to produce chemical actions there are necessarily actions in opposite directions—positive in the battery itself, where the current is generated, and negative in the apparatus where the current decomposes electrolytes. We have—Sec. I., pars. (*a*), (*b*), (*c*)—seen that these actions are equal at all points of the circuit and in all the elements which operate, whatever their direction.

Consider especially the experiment Sec. I., par. (*d*), in which Grove's batteries are arranged in tension, decomposing water in voltameters. Let N be the number of Grove cells and *n* the number of voltameters. The cells and voltameters give rise to electromotive force in opposite directions, and if P be the E.M.F. of an element, then N P will be the E.M.F. of the battery and *n* P that of the combined voltameters. The ratio of these forces will be $\frac{n\,P}{N\,P} = \frac{n}{N}$. Since there is as much gas consumed in each of the gas cells as there is produced in each voltameter, if Q is the volume produced in unit time, we have N Q the volume absorbed in the battery and *n* Q that furnished by the voltameters. The ratio of *n* Q to N Q or $\frac{n}{N}$ therefore expresses the proportion between the useful work done and the energy expended, and it is equal to the ratio of the positive and negative electromotive forces. This number, in fact, is the economic yield of the apparatus.

If it is desired to make the ratio equal to unity, *n* must be taken equal to N, but then the electromotive forces direct and inverse being equal there will be no work at all. Again, if N is increased with respect to *n* the work becomes more and more costly; nevertheless the current operates more and more rapidly, and the quantity liberated per second increases in proportion as the economic yield diminishes. The loss of energy here implied,

* An article by M. Marcel Deprez in *La Lumière Electrique*.

* The old unit of current, or Weber, was the current produced by unit electromotive force through a resistance of one ohm.—TRANSLATOR.

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or the difference between the energy expended and work done is due to heating of the circuit.

We have not, in the above, considered the resistance of the wires connecting the battery and the voltameters; but we will now take it into account. We have called the useful work done in the voltameters n Q, and the energy expended in the battery N Q; but since chemical action is proportional to intensity of current we have Q proportional to I—Sec. I., par. (*e*)—and the work done proportional to N. I. But by Ohm's law I. is equal to the electromotive force divided by the resistance; and the electromotive force of the circuit in this case is the difference of the two opposite electromotive forces of the battery and voltameters, namely, N P — n P. Hence we have the energy expended in the battery,

$$N Q = N I = N \frac{N P - n P}{R},$$

where R is the resistance of the circuit.

Similarly, the work done in the voltameters is—

$$n Q = n I = n \frac{N P - n P}{R}.$$

The ratio of these two quantities is, as we have seen, $\frac{n}{N}$, and it does not depend on the distance between the apparatus or the resistance of the circuit representing that distance. But, on the other hand, the value of the energy expended and the work done vary with the distance.

One can arrange, however, for this not to happen. In fact, the absolute chemical work produced in unit time as well as the economic yield, will remain invariable whatever be the distance, on condition that the electromotive forces direct and inverse vary proportionally to the square root of the resistance of the circuit.

To demonstrate this, let us consider the previous experiment, Sec. I., par. (*d*), in which the resultant current for the different opposed electromotive forces N P and n P had an intensity of $\frac{N P - n P}{R}$, where R is the resistance of the circuit. The economic yield is $\frac{n}{N}$.

Suppose, for example, the distance, and with it the resistance, becomes 25 times greater; but instead of N and n elements, we introduce into the circuit, according to the above rule, 5 N gas elements and 5 n voltameters, 5 being the square root of 25.

The intensity of the current will then be

$$\frac{5 N P - 5 n P}{25 R}, \text{ or } \frac{N P - n P}{5 R}.$$

It will therefore be five times smaller than the former; the chemical action in each of the elements will therefore be five times less energetic; but as there are on each side of the circuit five times the number of elements that there was before, the total quantity of energy expended and produced per unit of time, as well as their ratio to one another, will remain the same.

These theorems, established in considering only gas batteries, apply equally well to all kinds of chemical actions. The quantities expended or produced cease to be identical; but in virtue of the law of electro-chemical equivalents—Sec. I, p. (*e*)—they do not cease to be proportional to the same numbers, and the results will be the same.

We have now evalued the total positive work, and the useful negative work. We have found that they were proportional to the numbers N I and n I, in which I represents intensity, N the number of positive elements, and n the number of negative elements. It follows that these works are equally proportional to N P I and n P I, P being as before the electromotive force of an element of the battery. N P expresses, then, the total positive electromotive force, which we will call E, n p the total negative electromotive force, which we will call e; and the expressions of the positive and negative works become E I and e I respectively—that is to say, E I is the total chemical energy expended, and e I the useful chemical work produced.

After these explanations we can now formulate the conclusions to which we have been led:—

1. The positive chemical work representing the total energy expended is expressed by E I; for a given intensity it is proportional to E.

2. The negative chemical work is expressed by e I; for a given intensity it is proportional to e.

3. The economic yield is equal to the ratio of the negative electromotive force to the positive electromotive force.

4. The chemical work expended, the useful chemical work and the economic yield remain constant, whatever be the distance of transport, provided that the electromotive forces positive and negative vary proportionally to the square root of the resistance.

(TO BE CONTINUED.)

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The annual meeting of this society was held on the evening of the 15th inst., Professor FORSTER in the chair. From the annual report, read by the secretary, it appears that the society now numbers, including those elected on the evening of the meeting, 1,039 members. The losses by resignation or death during the current year have been 49, of whom five were officers of the Royal Engineers, deceased. No balance-sheet was placed in the hands of members, but the report stated that the finances of the society were in a satisfactory condition, the income gradually increasing, and the liabilities all cleared off. The effect of changing, or rather adding to, the title of the society, had been to bring into it a number of men of electrical eminence who, under the old title, might not have been attracted to it. Some account of the part taken by the society in the Electrical Exhibition and Congress at Paris was also given, the results of which were deemed highly satisfactory. A report from the librarian was then read. It showed that since the opening of the library to the general public since January last it had been visited by about 350 persons, non-members as well as members; but the greater portion of these visits had occurred during the past two months, showing that the advantages of the library were gradually becoming known and valued. About 140 additional books and papers had been presented to the library during the past year, and the specifications of all electrical patents were now accessible for reference there a week after publication. Nearly 500 of such patents had been taken out within the last twelve months, and the saving of time to persons interested by having the earliest possible information on a particular subject would be very considerable. Abstracts of American electrical patents were also received weekly. The librarian stated, in conclusion, that he had carefully examined the books at the Paris Exhibition, and it was satisfactory to know that nothing of importance was there that the Society did not already possess.

Mr. M. F. ROBERTS, F.C.S., in moving the adoption of the report, commented upon the mode of electing the nominees of the council adopted on this occasion. Only the exact number of persons required were nominated, and the members had no choice in the matter. The time allowed was so short, too, that it was impossible to agree upon any fresh nominations, even if the members wished it. He had less hesitation in calling attention to the subject because the nominations were unexceptionable, though the manner of election was by no means so.

The PRESIDENT at once rose to explain that the manner of election—that is to say, the nomination of no more than the number of vacancies—had been decided upon after careful consideration, and was carried, although against the opinions of some of the council, by a substantial majority. The method now followed was that pursued by many, indeed most, of similar societies, and it saved much annoyance to gentlemen who might allow themselves to be put up for election, but fail to obtain a seat. The council probably thought that of two evils—this, or the seeming disregard of the members' rights, which was only in appearance—the latter was the best to incur. Of course it was in the power of members to alter the rules if they saw fit.

Mr. H. R. KEMP, in seconding the adoption of the report, recommended that a useful addition to the library would be an index of the patent specifications, and he asked that this suggestion might be considered.

Votes of thanks were then passed to the Institute of Civil Engineers for the continued use of the lecture hall; to the honorary local and foreign secretries and treasurers; and to the honorary solicitor, Mr. Bristow.

At this point of the proceedings the result of the balloting for the new officers was made known, the scrutineers having returned after a brief absence, occupied in counting the few papers deposited. Lieut.-Colonel C. E. Webber, R.E., is the president for the forthcoming year; all the rest of the council were dutifully elected as per list forwarded to the members, and need not be repeated here.

Mr. C. F. VARLEY, F.R.S., then briefly described his "Convenient Form of Constant Battery of Very Small Internal Resistance." This was the battery patented by him in 1854, and was a modified form of the Daniell. That patent, Mr. Varley said, must have been carefully studied and often, for the same thing had been patented at least three times over since then, once by Sir W. Thomson, once as the Menotti, and once again as the Marie Davy battery. His invention, which was diagramatically illustrated to the meeting, could be found described in patent numbered 2,555, in the above-named year, and, after a lengthened experience of its serviceable qualities, he confidently recomended it as a most useful and convenient form. Several questions concerning this battery of battery having been asked and answered, the proceedings terminated.

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CABLE COMPANIES AND THEIR SERVANTS.

Another legal decision of considerable importance to cable operators, as well as to cable proprietors, had reached us from the other side of the Atlantic when our leader of the 3rd inst. was penned, but want of space has compelled us to postpone our comments upon that case until to-day. The Supreme Court in Equity, Halifax, N.S., was moved in August last by the Direct United States Cable Company to restrain one of their servants, Mr. Frank Bennett Gerrard, from entering the service of the American Cable Construction Company, contrary to his engagement with the first-named company, who were then his employers. We give the names of the defendant and plaintiffs for convenience sake, and not for the purpose of reflecting on the good faith of any of the parties concerned. The case is, unfortunately, a typical one, and, as it has at length been brought to the test of a competent tribunal, our comments are broadly upon the decision itself, not upon the individuals on either side who may have provoked it.

The plaintiffs, following what is, we believe, the usual custom of cable companies, require their servants to enter into a three years' engagement, the company undertaking not to discharge the servant without three months' notice or three months' pay, the servant, on the other hand, promising not to leave their service until the expiration of the three years, and not even then without giving three months' notice. The wording of this latter part of the agreement is as follows:—"The engagement is terminable by the officer or servant at or at any time after the expiration of three years by three months' notice in writing." The three years' engagement "certain," as it is called, is therefore certain as affecting the clerk's services, but is uncertain as affecting the clerk's employment, seeing that his employers may dismiss him with three months' notice or pay at any time they please. This, which at first sight seems rather unfair, is probably a necessary provision against misconduct on the part of the servant, a contingency that need not be provided against by him as touching his employers. At any rate, the operators, confident in their own stability of character and the solvency of the company, are quite satisfied with these stipulations; indeed, the defendant in the action we are now discussing makes no complaint on that score. His grievance is, or rather was, that having served his time he was not free to quit the service at an ordinary month's notice. Some details of a rather complicated and conflicting character here enter into the case. Mr. Gerrard ended his three years' engagement so long ago as 1877, having since then on several occasions been in correspondence with the plaintiffs in respect to increases of salary and a proposed new engagement. On one of these occasions he alleges that he apprised the company that he was not prepared to undertake a new agreement at the increased rate of salary then given him; and so confident was he of having relieved himself from the terms of the original agreement that his justification before the Court was that he considered himself then "working from month to month." Evidently Mr. Gerrard was honestly under that impression; and this being so, no fault can be found with the course he adopted. He wanted to leave at short notice, he thought he had the legal right, and he pressed to be allowed to exercise it. The Court, however, ruled otherwise, and ordered him to complete his term of three months from the date of his first notice. The words explaining this portion of the judgment may be of service to other operators in similar positions, and we quote the passage at length:—"Gerrard, in his answer, has shown nothing to justify his leaving the plaintiff company's service without notice. It is contended on his behalf that the term in the original agreement having expired, and no new agreement having been entered into, he has a right to leave; but he had engaged that he would at no time leave without giving three months' notice, and after the expiration of the first three years he continued in their service and received his salary."

Such is one aspect of this singular action—singular not in the rarity of the provocation, but in the fact that the employers have sought to legally enforce their rights. As a set off to that portion of the agreement telling against the *employé*, it should be remembered he may take himself off without any notice whatever, and for obvious reasons nobody will pursue him for damages. In the the case we are considering the defendant really wanted to join a new company, started, so to speak, next door to and in opposition to the old. It was alleged in the affidavits of the plaintiff company that the American Cable Construction Company, which was then laying an opposition line from Land's End (England) to the North American coast, and who were the co-defendants in the action, had "approached" several of the plaintiffs' operators with a view to illegally "seduce and entice" them away from their engagements and secure their services in the new venture. Moreover, that the said operators had been promised an indemnity against any damages they might be subject to in consequence of their breach of engagement; and it was further admitted, in one case at least, that the co-defendants' agent had pledged himself to this effect. Here, then, we have an explanation of a telegraph operator occupying the unique position of defendant in an action brought by a rich and powerful company; and here, also, we see why the other rich and powerful con-

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cern is made a co-partner in the defence. Everything is fair in competition, some people say, just as it is said to be in love and in war. There is, however, one thing regarded as not fair even in war—and that is the shooting of an enemy's sentinel. It seems to us that the proceeding just described partakes very much of this character. The operator loses his old situation in any case, and has nothing to count upon for the future but the verbal promise of an agent. This, however, is the operators' look out, and we mention it in order that they may be on their guard henceforward. Looking at the transaction as between company and company it is unfortunately only too common, though it is manifestly unfair. Operators become experts in the service of one company which has been at great pains, and often at considerable cost, to give the necessary training. Suddenly there springs up another company, rich in everything except experience; and it acquires this by bidding for the experience which rightfully belongs to the old concern. If the price were paid to the real sufferers they would have no cause to complain; but as a fact it is they who pay the penalty in loss of valuable service, in loss of efficiency, and in general disturbance of their arrangements.

Whether the plaintiffs gained much by delaying their clerks' entry into the opposition company's service is more than we can say; but they deserve the thanks of everybody concerned in cable working for getting this subject legally settled, at all events in one court. It may lead to some permanent improvement in the character of the agreements, and in any case will serve to make projecting companies a little more cautious, if not more scrupulous. Wishing all friends a merry Christmas, we commend this subject to their consideration during the new year.

CORRESPONDENCE.

THE ACCIDENT AT HATFIELD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the sad accident at Hatfield I deem it only fair to the Anglo-American Brush Electric Light Corporation that it should be known that, although the dynamo electric machine was obtained from them, they had nothing whatever to do with its installation, and the lamps and wires were neither supplied nor erected by them.

Our practice is always to use insulated leads of ample size, and although we have supplied hundreds of machines and lamps all over the country, we have never had a single instance of any serious accident.

Our experience is that electricity for lighting purposes, as for telegraphy and telephony, is a most docile and easily managed servant, if only ordinary care and prudence are exercised, and that under such conditions the public need not have any apprehension in availing themselves of the many valuable advantages that exist for them in adopting the electric light.—Yours &c.,

JAMES HUMPHREYS,
General Manager of the Anglo-American Brush Electric Light Corporation (Limited).

ELECTRIC LIGHT IN EARNOCK COLLIERY.—At a recent meeting of the Mining Institute of Scotland, Mr. Gilchrist, the secretary, gave an outline of the history of the Swan incandescent lamp since its introduction by Mr. Watson into his Earnock Colliery (*see Electrician*, Vol. VII., p. 262). He stated that a number of the lamps originally fitted were still in use, and had up to that time been burning as many as 1,040 hours, the average life of the others then in use being 700 hours. The average illuminating power was given as six candles.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

III.

We have now to picture to ourselves as vividly as possible a magnet as a bundle of filaments or magnetic axes, with a line of force starting from the north end of each axis, and curling round to the south end in the well known manner which is illustrated by the use of iron filings. The axis and the line of force together, therefore, form one continuous curved line, which is called an axis in the iron, and a line of force in the air; but, in its widest sense, the term line of force may be applied to the whole curve.

A line of force is to be thought of as having sense,* *i.e.*, it is not like a road, but like a river; it points out the direction in which a free *north* pole would travel, and you must always think of it as starting out from the north pole, and travelling through the air to the south pole, this being accepted as the positive sense. If you continue your journey along the axis you will be going from south to north in the iron. It is not easy to say what a north pole would do here, as one would have to make a cavity for it, but it is best still to call this the positive direction of the line, so that you go perpetually along the line in a closed circuit in the positive direction for ever.

Cut a thin slice off one end or out of the middle of a magnet, and you get a magnet whose axes are infinitely short, and whose lines, starting from one face, curl round to the other; in other words, you get a magnetic shell. Such a shell being merely a short magnet, will, if immersed in a magnetic field, behave precisely like a magnet, that is, it will tend to face round so that its axes are parallel to the lines of force in the field, and to move bodily forward in the direction in which the lines lie closest. This can be expressed by saying that it tends to move so as to get the greatest possible number of the field's lines of force to pass through it in the sense of its own lines.

If the field is uniform it will only experience a couple, if it is not uniform it will be translated as well as rotated.

It may also be expressed by saying that it moves so as to set its lines of force parallel and concurrent with the lines of force in the field, and then moves along them into regions of more intense force.

Constitution of a Magnetic Shell.

Think, now, what a magnetic shell really is according to the theory of Ampère; an assemblage of molecular currents side by side with their axes parallel. Draw such a set of currents on a plane and you will see that wherever molecules touch, the contiguous currents are in opposite directions, and therefore neutralise one another as far as external effect is concerned. The only currents able to produce external effect are those of the external portions of the peripheral molecules. Hence the lines of force produced by the shell ought to be the same as those due to a current circulating in its periphery; and this is found to be the case. The external action of a magnetic shell of any shape may be imitated exactly by making a current of certain strength circulate in a wire bent to fit the rim of the shell; and, conversely, the action of a current flowing in any closed circuit or contour can be imitated exactly by a magnetic shell of certain strength bounded by that circuit or contour. This is called *the equivalent magnetic shell.*

If, then, we have pictured to our minds the lines of force of a telephone disc, magnetised all north on one face and all south on the other, we have the lines of force also for a circular current. They are the same again as the lines of flow, when a Volta-disc of zinc and copper, soldered back to back, is immersed in an ocean of dilute sulphuric acid.

Behaviour of a Current in a Magnetic Field.

Every current of electricity flows in a closed circuit, and hence the behaviour of a closed circuit carrying a current includes every possible case. But a closed circuit behaves exactly like its equivalent magnetic shell; that is, it tends to move so as to include the greatest possible number of lines of force within its contour, the direction of the lines of force

* Sense is always typified by the head of an arrow.

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so included being the same as that of the included lines of force produced by the current itself.

If the lines of force be made to thread a circuit the wrong way (*i.e.*, in opposition to its own lines), then it will turn, to get rid of all these lines and to get them passing through the right way.

Behaviour of a Flexible or Elastic Circuit in a Magnetic Field.

It is instructive, now, to consider the case of a current flowing through a very thin, perfectly flexible thread. Let it be confined to a plane, and let the lines of force be passing through it in the right way; the circuit will expand and spread itself out till it is circular (in which shape it has the greatest area, and therefore includes the greatest number of lines), and if it be elastic it may still further stretch itself into a larger circle. Suppose, on the other hand, the lines of force had originally gone through the circuit the wrong way, then it would have shrunk till its area was nought, and opened out again the other way, virtually turning itself inside out.

If a circuit is mostly rigid, but has a single movable portion, then this portion will always move so as to increase the number of lines of force passing through the whole circuit in the right direction (a statement which must be held to include the fact that it moves so as to *decrease* the number of lines of force passing through the circuit in the *wrong* direction).*

With a bit of gold thread, or tinsel, or other flexible conductor, immersed in a magnetic field, all this can be interestingly shown; but, in the explanation, it is most conducive to clearness to take the *whole* circuit into account, and not the movable portion only, as is, unfortunately, too often done.

Moment of a Circuit.

It has been shown experimentally by Ampère, and more accurately by Weber, that a current flowing in a small plane circuit is equivalent to a magnet whose moment is the strength of the current multiplied by the area of the circuit. In other words, the magnetic shell equivalent to a given circuit must have a moment equal to the strength of the current flowing in it multiplied by the area of the circuit.

Let γ be the strength of the current flowing in a circuit of area A, then it is equivalent to a magnetic shell of moment γ A, bounded by the circuit; or, at distances great compared with the size of the circuit, its magnetic action is the same as any magnet in the same position with its axis pointing along the lines of force and of moment γ A.

We may call this, if we like, then, *the moment of the circuit.* If the current, instead of flowing once round the contour, flows round it n times, as in a coil of wire, the moment is n times as great; it is the same, in fact, as if the current flowed round a circuit of n times the area ;† hence this quantity, the area of the mean coil multiplied by the numbers of them, or n A, is sometimes, and conveniently, called the *effective* area of the circuit.

ELECTRIC LIGHTING FOR SHIPS AND MINES.

The third general meeting of the twenty-fifth Session of the Institution of Engineers and Shipbuilders in Scotland was held on Tuesday night, in the hall, 207, Bath-street, Glasgow, Mr. J. L. K. Jamieson presiding. Principal Jamieson, of the College of Science and Arts, read a paper on "Electric Lighting for Ships and Mines." He remarked that it was only about ten months since Swan's lamps or any incandescent lamps could be procured in any quantity in Great Britain. It was a still shorter time, about six months, since the plan of applying the electric light to steamships was thought of and adopted. During that period electric lighting had been introduced to the following amongst other ships:—H.M.S. "Inflexible," "City of Rome," "City of Richmond," "Servia," and "Alaska," by Swan's Electric Light Company. There had also been similarly fitted up two ships in America. In all probability there had been 1,400 or 1,500 lamps installed in different steamers, most of them first-class passenger steamers. From that fact it might be judged that the plan of lighting with the electric light instead of oil lamps was favourably received, and that in time it would become so popular that nothing else would be used aboard large steamers. The "Servia" was fitted up with 120 Swan lamps, worked by a Brotherhood three-cylinder patent engine, a Siemens' exciter, and an alternate current machine. That could not be done in the very complete way in which it had been done at a less cost than £1,000, or eight guineas per lamp. By having electric lighting aboard ships there were done away with all the smell and annoyance of oil lamps, the trimming and other inconveniences arising from the ordinary method of lighting with paraffin oil, and there was procured a steady, pure, white, and pleasant light, which passengers would like more and more. It gave no trouble to the steward or anybody connected with the ship, because a man was simply sent round once a day to see if any of the lamps required renewal. Mr. Swan's Company had fitted up with their electric light all the ships (six or seven) which had come to them, while Mr. Edison had dealt with two. In respect to mines there had been only two fitted up by Mr. Swan—namely, the Earnock and Risca. Mine owners were very cautious: they were quietly waiting to see whether the electric light in the two mines mentioned was successful. For the foot of the shaft and the ways leading to the shaft the electric light was very suitable indeed; it gave no trouble: all that was required was simply to turn on the engine in the morning, to have proper lubricating machinery, and to have a man looking at the engine every two or three hours. Some four of the Swan lamps at Earnock had been lighted for over 1,000 hours, and the average length of time that those at present in the mine had been lighted was over 700 hours, and these lamps had not yet given way. There was, therefore, a prospect of a good long life before them, if not unduly pressed beyond their present candle-power, which no doubt appeared brighter below in the mine than it would above ground in a bright room.—A vote of thanks was subsequently proposed to Mr. Jamieson for his address.

SUBMARINE CABLES.

The following memorial has been presented to the Secretary of State for Foreign Affairs:—

"London, December 12, 1881.

"My Lord: For some years past there has been an increasing recognition of the fact that submarine cables need protection from careless and wilful damage, and that the repairing operations necessarily consequent upon interruptions call in like manner for protection from careless and wilful interference. In the shallow waters of the Channel, the Irish Sea, the German Ocean, the Baltic, on the Newfoundland Banks, the bank along the coast of Nova Scotia, and in Massachusetts Bay interruptions sustained by submarine cables are almost without exception owing to damage occasioned by anchors and trawls; and wherever cables land all over the world, according to the greater or lesser number of ships frequenting the coasts, breakages from anchors are more or less numerous. In like manner, in all comparatively shallow waters where there is fishing with anchors, trailing, or trawling, the cables are broken or damaged so as to be rendered unworkable. In all these cases the cables are laid down on the charts, and might consequently be avoided. The precise manner in which these interruptions in shallow waters are caused may be concisely stated as follows:—By ships carelessly anchoring on the line of the cable or in dangerous proximity. By ships carelessly dragging their anchors across the line of the cable. By fishing boats fishing with an anchor out to direct their course, and trailing across the cable. By trawlers trawling with equal carelessness across the cable. By the use of badly-repaired trawls, or trawls out of repair, with projecting bolt heads clumsily attached, sharp-edged pieces of iron, and so on, which drag along the cable and injure it, thus destroying communication through it. By the wilful action of the crews of both ships and trawlers, who, when they find their tackle caught by the cable, bring the latter to the surface, and, instead of clearing it properly and letting it down to the bottom again, free their tackle by cutting the cable asunder. By ships navigating near cable steamers, both in cable-laying and cable-repairing expeditions. This danger has been much increased from a removeable cause which will be more fully dealt with further on.

"When the cables are found to be interrupted, and the locality of the fault has been ascertained by electrical tests, cable-repairing ships are sent out to effect the repairs, and their proceedings are carelessly and wilfully interfered with and impeded by the proceedings shortly described as follows:—By fishing boats casting their nets so as necessarily to drift across buoys and cable ships employed in repairing operations, thus delaying or rendering them for the time impracticable. By the destruction, carelessly or wilfully, of buoys attached to cable ends or anchored as mark buoys during repairs. By wilfully unshackling buoys and setting them adrift. These two latter proceedings, as often as they are repeated, render it necessary to go over all the work again. It would appear to be quite apparent that there can be no necessity for ships and fishing boats to drop anchor or fish along the bottom in dangerous proximity to cables when the whole sea and coast line are open. It would appear to be equally apparent that there can be no necessity for fishing boats to cast their nets in the direct line of cable-repairing ships and buoys so as inevitably to drift down upon them. It

* The facts are often stated by saying that a conductor carrying a current tends to move, if by moving it can cut lines of force. This nearly always comes to the same thing as the preceding, but it is a less intrinsically important way of expressing the facts. It is not the cutting of the lines of force *per se*, but the including or excluding lines from its contour, that exercises the important influence on the current.

† *Not*, be it noticed, the same as if the coil were opened out into one big loop. This would give a circuit of n^2 times the area of the single coil.

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must be apparent, on the other hand, that the cable ship is confined to particular ground; because it is there the cable is damaged or broken, and it it there, consequently, that she is compelled to work. That the ships employed are cable ships, and that they are employed upon cable work, is known, because the ships carry distinctive signals both by day and night. The position and course of a cable are equally known, because they are carefully laid down on the charts, and in many places, in addition, the course is given on shore by notice boards on the buildings about the harbour where mariners and fishermen congregate.

"The companies are of opinion that long immunity has allowed the careless and wilful proceedings described to grow almost into a system, although in many instances the parties occasioning damage themselves suffer. Probably the mischief originated in mere carelessness and thoughtlessness, inasmuch as there has been no actual prohibition of the proceedings described, and there has been no penalty to attract attention to disagreeable and discreditable consequences arising from these careless and wilful acts. Captains have probably unthinkingly dropped anchors where found merely convenient, and fishermen have cast their nets simply without reflection; when, as the natural result, the anchors have been held fast or the nets entangled, the wilful damage to the cable has followed from a feeling of exasperation. But the captain may suffer a day's detention to his ship or lose his anchor or chain; the fishermen may have their nets entangled and injured, and lose a day's fishing or more, owing to their fouling cables, ship, or buoys. Consequently international provision would be alike protective of the real interests of the mercantile marine and of the fisheries, as well as of the telegraph companies. If their causes be not checked, the interruptions and consequent irregularities of the telegraph service, which are already very damaging to commercial interests, threaten to become more so, and it must be advantageous from all points of view to diminish their frequency. The additional outlay directly and indirectly occasioned, and the losses of revenue caused, press heavily upon the companies. The capital invested, now amounting to £25,000,000, is unfavourably affected, and the whole system, as described, operates to discourage those enterprising investors who have placed this country beyond question at the head of telegraphic enterprise.

"In soliciting the support of such a form of protection as the Government may devise and believe to be attainable, the companies desire to lay stress more especially upon the points hereinbefore described. There are, however, two other matters which they venture to bring forward, and relative to which something might, perhaps, be done in the way of recommendation. During repairs, when personal communication with the shore at cable ends is necessary, this is prevented by quarantine regulations. In the West Indies the work of repair has been much facilitated by personal communication having been permitted under the surveillance of a quarantine officer, and the same has been done in the Levant by Greece: a general recommendation to countries to offer facilities such as above described would doubtless result in such facilities being afforded. The companies also would venture to ask that it might be made a recommendation to Governments to admit cable-repairing steamers to some kind of exemption from ordinary Custom-house regulations, light and harbour dues. These ships do not carry any kind of mercantile commodities or produce. They are solely engaged in maintaining submarine lines of international communication. They have frequently to enter harbour for shelter, and for the purpose of readjusting their stock of cable and refitting their lost cable, gear, and stores. On a recent occasion, when one steamer was obliged to enter a harbour in Spain to obtain from another ship a fresh supply of cable, permission to transfer the cable was absolutely refused, so that either the ship had to return to Lisbon, her last clearance port for fresh papers, or both ships had to put to sea outside Custom House jurisdiction, to enable them to transfer the cable, which they did. These circumstances delayed repairs for several days to a most important line of communication.

"A new and serious danger has recently become apparent, which, in addition to the inconvenience and damage which cable-repairing ships may sustain from its continuance, can hardly fail to result in the neglect and abandonment of ships in actual distress. The Board of Trade require that steamships which are not under control must carry three red lights one above the other, and cable ships while engaged in grappling consequently have to carry these lights. It is the practice of passing steamships, when they observe the 'not under control' signal, to assume that it is made by a disabled steamer signalling for assistance, and with the object of rendering aid they approach the cable-repairing steamer to their own danger from the buoys and from the cable which is being repaired, either of which might disable propellers and rudders by entanglement. A still more serious disaster might occur, should the commanders of steamships learn to assume that signals indicating a ship 'not under control' must belong to a cable-repairing ship, for a sinking steamer might have used all her rockets and be reduced to the 'not under control' signal as the only means of attracting attention. Passing vessels might disregard the signal, believing it to proceed from a cable-ship conducting her ordinary operations; consequently this identity of signals, for entirely different purposes, might be the actual cause of a sinking ship being unwittingly neglected, and left to sink. The attention of the Board of Trade has been several times drawn to this danger.

"There has been a difficulty in point of time in procuring statistical information, which would greatly tend to strengthen the representations made in this letter, but this may hereafter be furnished, if, in your lordship's opinion, it be desirable. The companies, therefore, now earnestly beg that your lordship may be pleased to take such steps, with the view of placing submarine cables under the protection of international law in view of the careless and wilful damage they are now subject to, as your lordship may deem most fitting. The companies have not asked, and do not propose to ask, for the neutralisation of submarine cables in time of war, as such a request would open up, not a question of mere international police, so to say, but considerations of such great imperial magnitude that any result would in all probability be indefinitely postponed. The companies further beg that your lordship may be pleased to receive a deputation representing the interests involved at such convenient time as your lordship may appoint.

"We have the honour to be your lordship's most obedient humble servants,

"Anglo-American Telegraph Company—MONCK, Chairman; H. WEAVER, Managing Director.

"Black Sea Telegraph Company, Eastern Telegraph Company, Eastern Extension, Australasia and China Telegraph Company, Eastern and South African Telegraph Company — JOHN PENDER, Chairman; JAMES ANDERSON, Managing Director.

"Brazilian Submarine Telegraph Company—THOMAS FULLER, Managing Director.

"Cuba Submarine Telegraph Company—THOS. HUGHES, Chairman; JAS. SCOTT, Secretary.

"Direct Spanish Telegraph Company—NIEL BANNATYNE, Chairman.

"Direct United States Cable Company—J. W. FULLER, Secretary.

"German Union Telegraph Company—GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

"Globe Telegraph and Trust Company, London, Platino, and Brazilian Telegraph Company—JOHN PENDER, Chairman; W. PAYTON, Secretary.

"Great Northern Telegraph Company—H. G. ERICHSEN, representative in England.

"Indo-European Telegraph Company—J. HOLLAND, Chairman; W. ANDREWS, Managing Director.

"Mediterranean Extension Telegraph Company—E. TOMBS, Secretary.

"River Plate Telegraph Company—GEORGE W. CLARK, Chairman; JOHN MANN, Secretary.

"Submarine Cables Trust—LEWIS WELLS, Secretary.

"Western and Brazilian Telegraph Company—ALEX. WOOD, Managing Director.

"West India and Panama Telegraph Company—C. W. EARLE, Chairman.

"The Right Hon. the Earl Granville, Secretary of State for Foreign Affairs."

ELECTRIC LIGHTING AT THE PARIS EXHIBITION.*

By WILLIAM HENRY PREECE, F.R.S.

(*Continued from page* 76.)

Among those that allow of a number on one section, perhaps the simplest in construction was the Gülcher, in the Austrian Section; but the most effective and original was the "Pilsen" lamp, the invention of Messrs. Piette and Krisik. It is called the "Pilsen" lamp from the place of its birth and from the want of euphoniousness in the names of its inventors. It was exhibited in the Austrian Section, and also in the British Section, by Mr. Fyfe. The carbons are kept apart by a sucking coil when the current flows; they are regulated by a second sucking coil, worked on a shunt. The peculiarity of the lamp consists principally in the shape of the core that controls the carbon; it is wedge-shaped at each end, its action is wonderfully regular, and almost perfect. Six lamps were worked in one circuit by a Schuckert machine.

The *Lampe Soleil*, which holds an intermediate position between arc and incandescent lamps, made a very effective display in the picture gallery, where there were 20 lamps in 10 lanterns. It is to be seen in London, lighting up the Panorama, in Westminster. It is a fixed, steady, durable lamp, giving a soft yellowish light, which is due to the fact that the arc maintains in incandescence a highly refractory substance like marble, between the two ends of the carbon. It is a very simple lamp, for it involves no mechanism whatever; but it is said to absorb a great deal of power, though I have seen no reliable figures of its performance. Its consumption of carbon is remarkably small. It is worked by an alternate current machine, which, like most of these machines, made a most unpleasant hum.

Carré made a very fine display of carbons for arc lights, for the manufacture of which he is so famous, in which the regularity of form, of structure, and of composition, is said to be absolute; but it is very questionable whether this is really the case in practice, for the irregularity of the arc lights is chiefly due to impurities and irregularities in the carbon. Moreover, the very vast discrepancies that are found in the photometric measurements of the same lamp at different times, or by different persons, may be due to the irregularities in the structure of the artificial carbon rods.

No one can deny that the Jablochkoff candle has done good service in the cause of electric lighting; but I am afraid that the exhibition in Paris has sounded the knell of all forms of candle, as well as those of the Werdermann type. The rising favourite is the incandescent lamp, pure and simple. The display made by Mr. Swan in the buffet in the Congress Hall, and in the Pavilion at the Post-office, was brilliant and effective. The light was soft, uniform, and yellow. The incandescent light is totally free from those bright rays that are so injurious to the eyes, so uncomplimentary to the complexion, and so irritating to the worker, if they are accompanied with the least unsteadiness. It is so readily under control; it requires no skilled labour to replace it or attend to it; it can be fixed anywhere; it can be worked into the fixtures and decorations of a room, and it does not damage them, as gas and oil do. Incandescent lamps can be worked by either continuous or alternate current machines. In fact, the chief lesson of the Paris Exhibition is this, that the arc light is suited only for external illumination, and that incandescent lamps are eminently adapted for internal and for domestic illumination. This lesson has been carried into practice at the Savoy Theatre, where nothing can be more effective or more efficient than the illumination of the auditorium. One can breathe pure air, feel cool, and can sit out a play without incurring a headache. There were several incandescent lamps shown at Paris besides those of Mr. Swan, notably those of Maxim and Lane-Fox; but that which possessed the greatest novelty, and was decidedly the most efficient, was that of Mr. Edison. The distinctive character of the Edison lamp is the remarkable uniformity of its texture and light-giving power. The lamp consists of a fine filament of carbon inserted as a part of the electric circuit in a glass globe, which has been exhausted of air to the utmost limit of workshop skill. A fine, uniform quantity of Japanese bamboo has been selected as that which gives the finest filament for carbonising. The bamboo is cut by special machinery into the required dimensions, and inserted into a mould, which is placed in a furnace, and raised to a very high temperature, and from which the filament comes out shaped and car-

* A paper read before the Society of Arts on Wednesday, December 14.

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bonised. Naturally grown vegetable fibre has been found to give a more uniform texture than any artificially-formed carbon. The ends are cut flat, and squeezed inside copper clamps, which are then welded together by electro-plating, the copper clamps being soldered to platinum leads, that are sealed through the glass, and are connected to the conductors. Perfect sealing is obtained by flattening the mass of the tube, through which the fine platinum wires pass, into a solid bar, so as to well fuse the wires and glass together. It is a fortunate thing for the permanence of the incandescent lamp that the co-efficient of expansion, due to heat, of glass and platinum is the same.

The normal lamp consists of a carbon filament long enough to give a resistance of 240 ohms when cold, and which, when permeated by a current of eight ampères, gives a light equivalent to 16 sperm candles. The half lamp is constructed with a carbon filament of just half the length and half the resistance, and gives eight candles. Other lamps are made with two and with four horseshoe filaments, so as to increase the light-giving power. The latter is a very beautiful lamp, giving a light of 64 candles, and will be used for illuminating the Holborn-viaduct. The features of carbon, which render it so highly adapted for incandescence, are its electrical resistance, its high refractory character, and its stability. The illumination of a filament and its durability are functions of the current that passes; the more intense the current, the higher the temperature, and therefore the brighter the light, and the quicker it goes. At a temperature of about 1,000º carbon becomes red, at 2,000º it is white, and the higher the temperature, the whiter it gets, until it fuses. A current of 0·8 of an ampère maintains an Edison filament at about 2,000°, when it gives a light of 16 candles, and it lasts on an average 1,100 hours. A stronger current will give a much better light, but it will not last so long. If it were possible to find a form of carbon, or any other material, which would be so refractory that we could transmit through it much stronger currents, the incandescent lamp would rival the arc lamp in brilliancy and power.

The destruction of the carbon filament is due to what is called the Crookes effect, a very slow transference of carbon, in a molecular shower, from the one heel to the other heel of the horseshoe, until a breakdown takes place at the former point. The better the vacuum the slower this effect. Alternate current machines are said to lengthen the life of the carbons, by equalising the distribution of molecules on each heel, but they do so at the expense of efficiency.

Many devices were shown for measuring the quantity of electricity consumed in any place by electric lamps, but that adopted by Mr. Edison is sufficiently simple and accurate for all practical purposes. A glass cell contains two copper plates immersed in a solution of sulphate of copper. A definite proportion of the current that passes through the house passes also through this cell, and deposits copper on one plate. The weight of copper deposited is an exact measure of the current used. There are two such cells—the one in charge of the consumer and the other of the supplier. They thus check each other.

Various plans were shown in different parts of the Exhibition to diffuse the light, but the most effective was that in *Salle* 15, where a Jaspar lamp filled the room with a shadowless light, by throwing a light on to a white screen above the lamp, whence it was scattered. The lamp itself was invisible. This plan is not novel. It was suggested by the Duke of Sutherland, and has been adopted by Mr. Schwendler in India.

The proper distribution of light is a problem that remains to be solved. It is argued that an arc is so much superior to an incandescent light, that one horse-power in the former gives you ten times more light than in the latter. This is true; but, on the other hand, to obtain a subdued light sufficient for your purpose, you must either put the arc lamp far away or tone it down by shades, and, therefore, waste it; whereas an incandescent lamp can be toned down, by regulating the current, to any colour you like, and it can be fixed just where it is wanted. One horse-power will give you 1,500 candles in an arc, and only 160 candles in 10 incandescent lamps; but these 10 lamps can be so distributed about your space to be lit, as to illuminate your surface or objects with a better light than the arc.

Curiously enough nothing whatever was done in Paris to improve the illumination of streets. The Avenue de l'Opera still remains as it was in 1878, the first street practically lighted by electricity; but prior to the opening of the Exhibition a portion of the Boulevard des Italiennes was lit up by four De Meraune lamps, suspended high up, at wide intervals, over the centre of the road. The effect was very fine, but the lamps were very bad. This is the true way of illuminating streets, and it is to be regretted that such an experiment is not tried in London. Street illumination in England by electricity up to the present time is, as a rule, a failure.

The question remains for discussion, has the electric light been brought within the region of practical domestics? I have no hesitation in saying that it has; but whether it can be brought into economical contrast with gas, experience alone will show. Several houses are already illuminated by its agency; others are in hand, my own amongst the number; and when we next meet on this subject I may be able to answer the question with actual facts.

One word as regards the danger of electric lighting. There is no use blinking our eyes to the fact that electricity can be a dangerous servant in the hands of the careless and ignorant; in the hands of the skilled it has less danger than gas, or even oil. The installation of the wires must be controlled by experience and knowledge. I have more than once called attention to this fact, and my warnings have been received with abuse; but in Paris there were no less than five incipient fires, from the wires coming in contact with each other, in the Exhibition buildings. *The Times* correspondent in Vienna implies that the frightful disaster to the Ring Theatre was due to this cause. The instances in New York are so numerous that the Board of Fire underwriters have issued the following rules:—

"1. Wires to have 50 per cent. excess of conductivity above the amount calculated as necessary for the number of lights to be supplied by the wire.

"2. Wires to be thoroughly insulated and doubly coated with some approved material.

"3. All wires to be securely fastened by some approved non-conducting astening, and to be placed at least 2½ inches for incandescent light, and 8 inches for arc lights, from each other, and 8 inches from all other wires and from all metal or other conducting substance, and to be placed in a manner to be thoroughly and easily inspected by surveyors. When it becomes necessary to carry wires through partitions and floors, they must be secured against contact with metal or other conducting substance in a manner approved by the inspector of the Board.

"4. All arc lights must be protected by glass globes enclosed at the bottom to effectually prevent sparks or particles of the carbons from falling from the lamps; and in show-windows, mills, and other places where there are materials of an inflammable nature, chimneys with spark arrestors shall be placed at the top of the globe. Open lights positively prohibited. The conducting framework of chandeliers must be insulated and covered the same as wires.

"5. Where electricity is conducted into a building (from sources other than the building in which it is used) a shut-off must be placed at the point of entrance to each building, and the supply turned off when the lights are not in use. Applications for permission to use electric lights must be accompanied with a statement of the number and kind of lamps to be used, the estimate of some known electrician of the quantity of electricity required, and a sample of the wire (at least three feet in length) to be used, with a certificate of said electrician of the carrying capacity of said wire. The applications should also state where the electricity is to be generated, whether the connection will have metallic or ground circuit, and, as far as possible, give full details of the manner in which it is proposed to equip the building."

These rules are very simple, and are necessarily carried out by every qualified electrician, but an additional security is obtained by Mr. Edison by inserting in every branch wire a "safety catch," which is a short piece of lead wire that instantly melts if the strength of the current exceeds a certain value, and thus ruptures the circuit, stopping the flow of electricity, and producing safety.

The completeness of Mr. Edison's exhibit was certainly the most noteworthy object in the Exhibition. Nothing seems to have been forgotten, no detail missed. There we saw not only the boilers, engines, and dynamo machine, but the pipes to contain the conductors; the conductors themselves, heavy and massive, for Mr. Edison recognises the waste of energy that must occur in small conductors, the insulation, the fixtures, the brackets, the safety catches, the lamps, devices to avoid the effects of expansion and contraction through change of temperature, meters to measure the current used, regulators to control the consumption of fuel. In a properly-regulated system there ought to be no waste of fuel. The engine driver has an indicator which shows him exactly what current is going out, and he has simply to regulate his firing by this indicator. Moreover, by the use of a rheostat, he is also able to regulate the outgoing current, so that he is able to maintain a perfect ratio between the fuel consumed and the light evolved.

The system is self-regulating if the electromotive force is kept constant, and the resistance of the lamps be uniform. We have the dynamo machine at one end of the circuit and a lamp at the other. The circuit is complete; a small current flows, which is determined by the resistance of the lamp alone, if the main conductors are made sufficiently large to neglect their resistance. Additions and subtractions of lamps only vary the resistance, and therefore the current. Turning off one lamp does not interfere with the rest. The limit of the number of lamps inserted is determined by their resistance, and by the heating of the armature; hence the value of high resistance in the lamps, and low resistance in the armature, of the dynamo-machine. Every lamp induces, as it were, its own current. We have not a store of electricity which has to be subdivided, but we generate our energy as we want it. This is the promising feature of the system. It is a principle of multiplication, rather than of sub-division, and leads one to anticipate economy in its working. Mr. Edison's system has been worked out in detail, with a thoroughness and a mastery of the subject that can extract nothing but eulogy from his bitterest opponents. Many unkind things have been said of Mr. Edison and his promises: perhaps no one has been severer in this direction than myself. It is some gratification for me to be able to announce my belief that he has at last solved the problem that he set himself to solve, and to be able to describe to the Society the way in which he has solved it.

The question that determines the size and insulation of conductors is a commercial one, and is regulated by the relative economy of waste of energy or interest on capital expended. If an expenditure of £100 per mile saves you £10 a year in fuel, it is clearly better to expend £100 on your conductor. If, on the other hand, it would save you only £2 a year, it is better to utilise your capital elsewhere. Every inch of conductor means waste of energy; the shorter and heavier it is, the less the waste; but as some waste is imperative, it is simply a matter of calculation to determine which shall be wasted least, capital or fuel.

It may be taken as a rule that any system dependent on the exercise of abnormal energy is certain, sooner or later, to break down; we all of us hate personal supervision, and personal supervision at home is a species of abnormal energy. This is the great secret of the success of gas. It is the cause of the slow progress of the arc light; but it is because the incandescent light promises to rival gas in this respect that such a future is open to it.

The awards at the Paris Exhibition were liberally bestowed by the jury, perhaps too much so; but matters were hurried up towards the end, owing to political difficulties, and the conclusions were necessarily hasty. No proper measurements or tests were made by any jury, but a committee, presided over by M. Tresca, has since been formed to continue the work, and there is no doubt that most valuable results will be obtained, for the desire of the jury to procure reliable measurement has been very generally met by the exhibitors. I had great hopes of being able to give you them to-night, but the reports are not yet complete.

We shall all, very soon, have a repetition on a different scale, and in a different way, at the Crystal Palace, and I have little doubt that, in its way, the Crystal Palace Exhibition will be as fine and as interesting as that at Paris.

INSTALLATION OF A MASTER FREEMASON BY ELECTRIC LIGHT.—The ancient order of Freemasons have introduced the electric light into their mystic ceremonies. We read that the installation of the W.M. at the St. Leonard Lodge, No. 1,766, on Dec. 14, was celebrated under the electric light. The lamps, which were supplied by Mr. James Fyfe, himself a mason, were on the Pilsen system, and were fed by a Schuckert machine. The machine and generator were lent by Messrs. Wells, of Shoreditch, for the occasion.

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RECENT INVENTIONS.

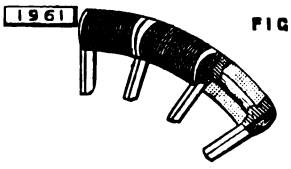
ABSTRACTS OF SPECIFICATIONS.

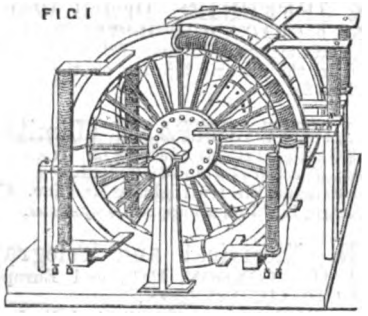
1577. IMPROVEMENTS IN ELECTRIC TELEGRAPHS, &c., *J. Hopkinson and A. Muirhead.*—11*th April*, 1881. 2*d*.

This invention relates to the use of dynamo-electric machines for producing currents for telegraph purposes, combined with secondary batteries.

1961. IMPROVEMENTS IN MAGNETO-ELECTRIC MACHINES, *G. Paget-Higgs.*—5*th May*, 1881. 10*d*.

These improvements relate to modifications in the armature, and the arrangement of field mag-

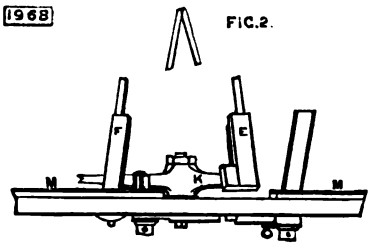


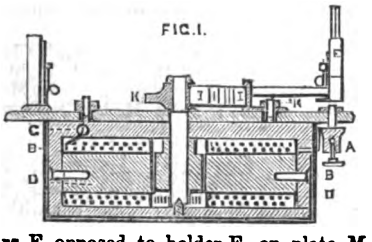


nets. The machine will be best understood from the drawings.

1968. IMPROVEMENTS IN ELECTRIC LIGHTING APPARATUS, *W. R. Lake.*—5*th May*, 1881.—(*A communication from N. Bouliguine.*) 6*d*.

The inventor arranges for six pairs of carbons on one plate, the carbons being inclined at an angle, as shown in Fig. 2. The action of the lamp is, the current enters at A, goes through wire around magnet D, and by a screw, G to B, thence by I to the arms K, upon which are carbon





holders E, opposed to holder F, on plate M, by which means all the holders like F are connected. The current passing causes the magnets to act on the armatures, and the pair of carbons offering the lowest resistance give the light, which passes from pair to pair according to the variation in the resistance.

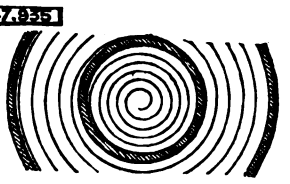
247,934. ELECTROPHORE OR SECONDARY BATTERY, *James A. Maloney, Washington, D.C., assignor by direct and mesne assigments to the American Eletrophore Company, same place.*—*Filed July* 6*th*, 1881.

Claim.—The process of preparing electrophores or secondary batteries for use, which consists in first submerging the metal coils in acidulated water, and then placing the device in an electric circuit for the purpose of polarising the leaden coils or plates, and, secondly, in subsequently replacing the acidulated water with water without acid for the purpose of conducting the cur-

rent to the respective polarised plates, substantially and for the purpose set forth.

247,935. ELECTROPHORE OR SECONDARY BATTERY, *James A. Malony and Frenz Bürger, Washington, D.C., assignors, by direct and mesne assignments, to the American Electrophore Company, same place.*—*Filed July* 20*th*, 1881.

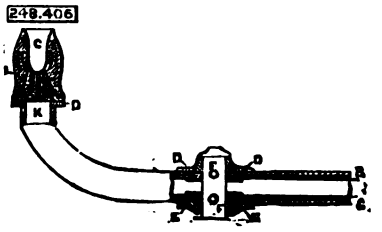
Claim.—An electrophore or secondary battery substantially as described, consisting of an exterior non-conducting vessel containing a central porous cup, two coils of the same metal coated



with red, and one arranged within the porous cup and one without the porous cup, both vessel and porous cup being filled with acidulated water, for the purpose specified.

248,406. GAS AND ELECTRIC LAMP FIXTURE, *George Crosby, New York, and Edwin M. Fox, Brooklyn, assignors to the American Electric Light Comany, New York, N.Y.*—*Filed April* 20*th*, 1881.

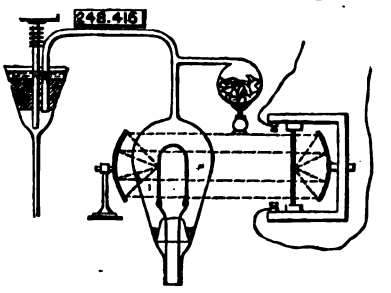
Brief.—The gas burner can be exchanged for an electric lamp at will. The gas cock is arranged to turn on the gas and shut off the electricity simultaneously. *Claim.*—A combined gas and electric light fixture, consisting of a pipe containing two insulated circuit wires with interchangeable burners for the ends of the pipe for the electric light or gas, combined with a single cock or plug valve, arranged, as described, to control the flow of gas or the electric current, as desired. The combination of the gas pipe, the insulated wires B and C, having insulated contact, D D^1,



and E E^1, disconnected from each other, and the non-conducting cock or plug, having a gas orifice, G, and metal bars, F F, arranged in the plane of the wire contacts, substantially as and for the purpose described. The combination of the gas pipe, the insulating plate D, the wires B and C, having contact faces, B^1 E^1, the screw nozzle K opening into the gas pipe, and the non-conducting socket C having contact plates, H H, wires I, and plates at their lower ends adapted to make electrical connection with the faces B^1 C^1 as and for the purpose described.

248,416. MANUFACTURE OF CARBONS FOR ELECTRIC LAMPS, *Thomas A. Edison, Menlo Park, N.J., assignor to the Edison Electric Light Company, New York, N.Y.*—*Filed January* 11*th*, 1881.

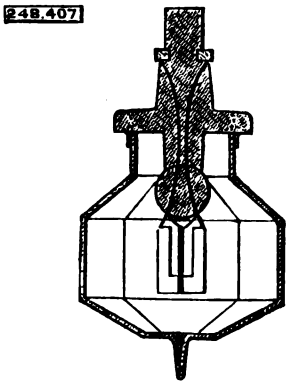
Claim.—(1) The within-described process of building up or strengthening a defective point in an incandescing conductor for electric lamps, consisting in heating that point to a high temperature by concentrating thereon the heat from an external source, and at the same time allowing a carbon vapour to enter the globe and deposit additional carbon on the heated point, substantially as set forth. (2) The appartus for building up or repairing defective carbon filaments, consisting of a separate vessel containing a solid hydrocarbon compound volatisable at low heat, means for passing the vapour into the chamber of the lamp containing the carbon filament, and means for raising any desired portion of the filament to a high temperature by concentrating or focussing upon said portion rays of heat, substantially as shown and described. (3) An electric lamp consisting of a globe inclosing a carbon



filament and conducting wires, and arranged to contain a portion of a solid compound of carbon volatisable at low heat, substantially as shown and described.

248,407. ELECTRIC LAMP, *George Crosby, New York, and Edwin M. Fox, Brooklyn, assignors to the American Electric Light Company, New York, N.Y.*—*Filed April* 12*th*, 1881.

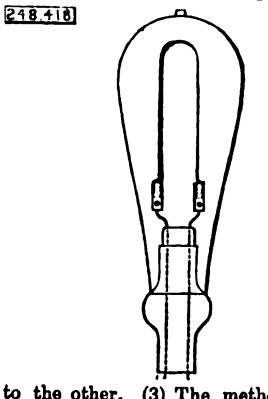
Claim.—(1) The incandescent conductor for an electric lamp, consisting of broad and thin U-shaped pieces inverted and arranged as described, with their planes bisecting each other and radiating from a common centre, whereby every plane surface is exposed for direct radiation of light, as described. (2) As a new article of



manufacture, a heavy cut glass globe for an electric light, made in one piece, with polygonal faces, and a relatively thin teat at the top, as described. (3) The combination, with an electrical lamp, of a heavy glass globe or covering made of one piece, and having polygonal faces, and provided with a relatively thin teat at the top, as and for the purpose described.

248,418. ELECTRIC LAMP, *Thomas A. Edison, Menlo Park, N.J., assignor to the Edison Electric Light Company, New York, N.Y.*—*Filed January* 31*st*, 1881.

Claim.—(1) A carbon for an incandescing conductor for an electric lamp, having one of its ends or portions of less resistance and greater mass of matter than the other, substantially as set forth. (2) A carbon for an incandescing conductor for an electric lamp, tapering from one



end to the other. (3) The method of utilising defective or spotty carbons for incandescing conductors in electric lamps, consisting in arranging them in the lamps, or the lamps in the circuit, so that the more perfect side is the negative portion, substantially as set forth.

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THE ORIENTAL TELEPHONE COMPANY (LIMITED).

Notice is given that an extraordinary general meeting of the members of the above company will be held at the City Terminus Hotel, Cannon-street, London, on Wednesday, December 28, 1881, at 12 o'clock noon, for the purpose of considering and, if thought desirable, of passing a resolution approving and confirming a certain conditional agreement made, or intended to be made, between Alexander Graham Bell of the first part, Thomas Alva Edison of the second part, the Oriental Bell Telephone Company of the third part, the Anglo-Indian Telephone Company (Limited), of the fourth part, George Edward Gouraud, Gardiner Green Hubbard, John Parks Bigelow, William Walter Cargill, and James Merrill Ormes of the fifth part, and this company of the sixth part, whereby it is proposed to effect various modifications or alterations in the subsisting agreements, for the purchase by the company of the properties and rights described in the agreement of the 25th of January, 1881, referred to in the memorandum and articles of association of this company, and the said other agreements, or some, or one of them particularly by reducing the amount of the consideration to be paid by this company for such purchase.

BRITISH AND IRISH TELEPHONE AND ELECTRIC WORKS COMPANY (LIMITED).

The first ordinary general meeting of the British and Irish Telephone and Electric Works Company (Limited) was held on the 14th inst. at the Salisbury Hotel, Fleet-street, under the chairmanship of E. B. Bright, Esq.

The CHAIRMAN, in the course of his remarks, said, by reason of the comparatively moderate capital of the Company, they were enabled to offer the public telephonic facilities on much lower terms than the existing telephone companies could do to yield any fair return on their much larger capitals. He also stated that a satisfactory commencement of business had been made, but so far the Postmaster-General had declined to grant the Company licenses for the establishment of telephonic exchanges, although the company's terms to the public would only be about one-half the rates of the United Telephone and other companies who had entered into a compact with one another to establish a monopoly, and to all of whom the Postmaster-General had granted such licenses as this company now seek to obtain.

The CHAIRMAN also referred to the litigation pending with the United Telephone Company, which would be carried on to the bitter end in order to test the validity of the Bell, Edison, and Crossley patents.

Much dissatisfaction was expressed by the shareholders present at the action of the Postmaster-General, and it was moved by Mr. Gaskell, seconded by Mr. Parry, "That this meeting express their surprise that the company's operations should be hampered by the withholding of the facilities for telephonic exchanges afforded by the Postmaster-General to other companies and individuals, and that no reply or even acknowledgment has been received to the subsequent letters of the chairman to the secretary of the Post Office, dated the 8th and 30th November last. That, failing the receipt of a satisfactory reply from the Post Office by the 20th inst., it be an instruction to the board to publish the correspondence, and to take such action either by memorial to Parliament or otherwise as may be deemed advisable."

These resolutions were put and carried unanimously.

It was reported that a very prominent position had been allotted to this Company for its exhibits of railway telegraphs, telephones, and other apparatus at the forthcoming International Electric Exhibition at the Crystal Palace.

The retiring directors were then re-elected, and a vote of thanks to the chairman for presiding closed the proceedings.

COMPANIES' SHARE LIST.

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COMPANIES.	CLOSING PRICES DEC. 21.		BUSINESS DONE WEEK ENDING DEC. 21. Highest.		Lowest.	
Anglo-American	51¼,	51¾	51¾		51¼	
Do. Preferred	79¼,	80¼	80¼		79¼	
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Cuba	9¼,	10	—		—	
Do. Preference	16,	17	—		—	
Direct Spanish	5,	5¼	5¼		5¼	
Do. Preference	14½,	15½	—		—	
Direct United States Cable	10⅜,	10½	10½		10½	
Eastern Telegraph	10½,	10¾	10¾		10	
Do. 6 per Cent. Preference	12¾,	12¾	12¾		12¾	
Do. 5 per Cent. Debentures, 1899	105,	108	—		—	
Eastern Extension	10⅞,	11¼	11¼		11	
German Union	10,	10½	10¾		10⅜	
Globe Telegraph and Trust Company.	6¼,	6½	6 11-16		6 9-16	
Do. Preference	12¾,	12¾	12¾		12¾	
Great Northern	12,	12½	12½		12¼	
Indo-European	27½,	28½	28½		28½	
Mediterranean Extension	2¼,	2¾	—		—	
Do. Preference	9¼,	10	—		—	
Reuter's	12,	12½	—		—	
Submarine	290,	300	—		—	
West India and Panama	1¾,	2¼	1¾		1¾	
Do. 1st Preference	7¼,	8	7¾		7¾	
Western Brazilian	7⅛,	7¾	7¾		7¾	
West. Union 7 per Cent. 1st Mortgage	123,	128	—		—	
Do. 6 per Cent. Sterling Bonds	104,	107	—		—	

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United Telephone	11¼,	11½	—		—	

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For Press opinions vide "Times," 18th; "Iron," 18th; "Engineering," 18th; "Electrician," 19th Nov., 1881; "Telegraphic Journal," 1st Dec., 1881, &c.

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2. BATTERIES and ALLIED APPARATUS.
3. MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.
4. CABLES, WIRES, LIGHTNING CONDUCTORS.
5. APPARATUS FOR MEASURING ELECTRICITY.
6. TELEGRAPHS AND SIGNALS.
7. TELEPHONES, MICROPHONES, PHOTOPHONES.
8. ELECTRIC LIGHTING.
9. ELECTRIC MOTOR POWER.
10. ELECTRO-MEDICAL.
11. ELECTRO-CHEMISTRY.
12. MAGNETS, COMPASSES, HOROLOGY, etc.
13. MISCELLANEOUS.
14. GENERATORS, GAS, STEAM, WATER ENGINES, etc., APPLICABLE TO ELECTRIC INDUSTRIES.

SPACE HAS ALREADY BEEN ALLOTTED TO THE FOLLOWING EXHIBITORS:—

CLASS VIII.—ELECTRIC LIGHTING.

Anglo-American Brush Light Corporation.
British Electric Light Company.
Cance, A.
Clark (Latimer), Muirhead and Co.
Compagnie Générale d'Electricité.
Crompton, R. E.
Edison, T. A.
Electric Light and Power Generator Company.
Electric Light Engineering Company.
Electric Lighting Supply Company.
Electric Light Carbon Company.
Elmore W.
Gerard, A.
Graham, D. H.
Gravier and Co.
Hammond and Co.
Hawkes (G.) and Co.
Henley, W. T.
Macdonald, J. Hay Athole.
Mignon et Rouart.
Rowatt and Fyfe.
Scientific Toy Company.
Siemens Brothers and Co.
Siemens Frères.
Somzée, M. Leon.
Swan Electric Light Company (Limited).
Strode and Co.
Thomas, Evan.
Varley (S. A.) and Co.
Werdermann, R.
White House Mills Company.

Announcements of other allotments will be made from time to time.

COMPAGNIE FRANÇAISE DU TÉLÉGRAPHE DE PARIS À NEW YORK.

REDUCTION OF TARIFF.

On and after 1st August, 1881, the rate for the transmission of Telegrams from the United Kingdom to NEW YORK and CANADA will be

1/- per word.

The name of the place from which Messages originate will be transmitted free of cnarge.

Rates to other places and further particulars may be obtained at the following Offices of the Company:—

Open Day and Night.

LONDON: 24, ROYAL EXCHANGE, E.C.
LIVERPOOL: H5, EXCHANGE BUILDINGS.
NEW YORK: 135, BROADWAY, and Corner of Exchange Place and Broad Street

The Public are recommended to hand in their Messages at the Company's Stations, as above, where receipts are given for the amounts charged.

Messages for this Company's Cables will be received at any of the Postal Telegraph Stations throughout the United Kingdom. Attention, however, is called to the IMPORTANCE of SENDERS WRITING DOWN on the FORMS for AMERICAN MESSAGES, which are specially provided at Post Office Telegraph Stations, the indication,

"Via FRENCH" or "Via PQ."

This is signalled as an official instruction, and not charged for.

Books of this Company's Message Forms and further information can be obtained on application to

24, ROYAL EXCHANGE, LONDON, E.C., & H5, EXCHANGE BUILDINGS, LIVERPOOL.

NEWALL'S PATENT LIGHTNING CONDUCTORS.

Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

NEWALL & CO.'S PATENT COPPER-ROPE LIGHTNING CONDUCTOR,

As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public. It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

SOLE PATENTEES OF UNTWISTED WIRE ROPE.

Manufacturers of Iron and Steel Ropes for Colliery and Railway purposes. Rigging Ropes, Guide Ropes, &c.

Gilt and Silver Cord for Hanging Pictures. Iron, Steel, and Copper Cord for Clock and Sash Lines, &c.

R. S. NEWALL & CO., LONDON, 130, STRAND, W.C.

LIVERPOOL—36, Waterloo Road. GLASGOW—68, Anderston Quay. Manufactory—GATESHEAD-ON-TYNE.

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices—17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS,

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

JOHNSON'S

PATENT

TRANSMITTER.

BELL'S PATENT

TELEPHONE.

The best combination for Exchange and Private Lines.

TASKER, SONS, and CO.,

ELECTRICAL ENGINEERS,

SHEFFIELD.

HARBOROW & CO.,

ELECTRIC LIGHT ENGINEERS

AND

TELEGRAPH INSTRUMENT MANUFACTURERS,

4, CIRCUS STREET, LONDON, W.

Just published, Crown 8vo., cloth, 12s. 6d.

A HANDBOOK of ELECTRICAL TESTING. By H. R. KEMPE, Member of the Society of Telegraph Engineers, Assoc. Mem. Inst. C.E. Second Edition, Revised and Enlarged.

London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street.

Now ready. With numerous engravings. 8vo., cloth, 7s. 6d.

LIGHTNING ROD CONFERENCE.—REPORT of the DELEGATES from the following Societies, viz.:—The Meteorological Society, the Royal Institute of British Architects, the Society of Telegraph Engineers and Electricians, and the Physical Society. With a Code of Rules for the Erection of Lightning Conductors, and various Appendices. Edited by the Secretary, G. J. SYMONS, F.R.S.

London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street.

ELECTRIC LIGHT.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

Capital £800,000; First Issue £400,000.

VICTORIA WORKS, BELVEDERE ROAD, & VINE STREET, LAMBETH.

The Corporation is prepared to give estimates and to book orders for the SUPPLY of MACHINERY and LAMPS, upon the Brush System, for lighting up Factories, Warehouses, Railway Stations, Docks, Streets, &c.

The Corporation are willing to receive applications for licences or concessions for defined districts, counties, or towns in the United Kingdom.

By the Brush system any number of lights, from 1 to 40, each of 2,000 candle power, or any number from 1 to 12, each of 6,000 candle power, or a single light of 50,000 or more candle power, can be produced from one dynamo machine. The connecting wires may be extended over circuits of many miles, and it is claimed that economy, constancy, and simplicity are secured at a less cost than by any other system.

The Corporation is also prepared to supply for domestic lighting, incandescent lamps of 10-candle power and upwards, manufactured with the newest improvements, under the "Lane-Fox" system. These lights are suitable for private houses, business offices, clubs, hotels, &c.

Concessions for the colonies and for foreign countries of the valuable patent rights under both of these systems, including methods of manufacture, regulation, and distribution, can be negotiated with the Corporation.

All inquiries to be addressed to the Secretary, at the offices, Belvedere-road, Lambeth, S.E.

WINCHESTER.—The Lighting Committee of the Town Council are prepared to receive SUGGESTIONS for LIGHTING the STREETS of the CITY by means of ELECTRICITY. Particulars to be sent to me on or before the 14th of JANUARY NEXT. The Committee do not pledge themselves to adopt any system or be liable for any expenses to be incurred.

By order, WALTER BAILEY, Town Clerk.

Guildhall, Winchester, Dec. 19, 1881.

RESIDENT ELECTRICAL ENGINEER WANTED, young, active man, to superintend the National Telephone Company's Works, Edinburgh. State age and experience. Apply to the SECRETARY, Frederick-street, Edinburgh.

ESTABLISHED 1851.

BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane

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SLIP

TUNIS.—Telegraphic communication between Susa and Tunis is restored.

BRITISH GUIANA.—Telegraphic communication with British Guiana is interrupted, the cable between Trinidad and Demerara being broken.

ELECTRIC LIGHT IN SOUTH AFRICA.—An experiment has been made with the Brush light as a means of illuminating the Cape Town Docks.

THE BRUSH LIGHT IN LONDON.—Messrs. Hammond and Co. are introducing this light into High-street, Whitechapel, and Commercial-road East.

THE ELECTRIC LIGHT IN CHURCH.—We hear that Maxim and Edison's incandescent lamps are to be used in the church of St. James, Westmoreland-street, Marylebone.

THE ELECTRIC LIGHT FOR UXBRIDGE.—The Local Board of this town have appointed a committee to consider the question of introducing the electric light into the town.

THE TELEPHONE IN CHURCH.—A telephone line has been erected between Holy Trinity Church, Southport, and the residence of an invalid member of the congregation.

ANGLO-CONTINENTAL TELEPHONE COMPANY.—The offices of this company have been removed from Crown Court-buildings, Old Broad-street, to 31, Queen Victoria-street, E.C.

ELECTRIC LIGHT FOR LAMBETH.—We believe that the Lambeth Vestry are about to light the street from Westminster Bridge up to the Horns at Kennington by electric light.

ELECTRIC LIGHTING FOR PADDINGTON.—The Vestry of Paddington have desired their General Purposes Committee to report upon the question of electric lighting for the parish.

ELECTRIC RAILWAY AT CHARLOTTENBURG.—It is announced that the electric railway between Spandau and Charlottenburg is a success. The railway is constructed with a rising gradient all the way.

ROYAL INSTITUTION.—We regret to hear that Dr. Warren De La Rue, who has been in bad health for some time past, has for that reason been compelled to resign the honorary secretaryship of this institution.

COUPONS.—The coupons due Jan. 1 on the Five per Cent. Mortgage Debentures of the Eastern and South African Telegraph Company (Limited) will be paid on and after that date by Messrs. Barclay, Bevan, and Co.

TELEGRAPHS INTERRUPTED IN ITALY.—Advices from Italy, dated the 19th instant, say that the storm of Thursday, the 15th instant, damaged all the Calabrian lines of telegraph, and suspended communication with Sicily.

ELECTRIC LIGHT IN INDIA.—The *Homeward Mail* says that the Poonah Cantonment Committee have applied to the Commander-in-Chief for sanction a proposal to introduce the electric light within the cantonment limits.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th December are £2,407 as compared with £1,375 in the corresponding period of 1880.

CRYSTAL PALACE ELECTRICAL EXHIBITION.—The Town Council of Coventry have resolved to send a deputation to attend the above exhibition, and report thereon as to the applicability of electric lighting to that town.

ELECTRIC LIGHT COMPANY.—The Société Industrielle d'Electricité has been registered at Brussels. It is formed to work the patents for the Lampe-Soleil. The capital is 1,200,000fcs., in 12,000 shares of 100fcs. each.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 23rd December, 1881, were £2,747, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

LIGHTNING RODS.—The report of the Committee on Lightning Rods, composed of members of the Society of Telegraph Engineers, Meteorological Society, Physical Society, and Institute of British Architects, which was appointed in 1878, is published by Messrs. Spon and Co.

SOUTH AFRICAN TELEGRAPHS.—It is notified that the Cape of Good Hope has entered the International Telegraphic Convention. This fact does not, however, affect the present rates for telegrams to the Cape per Eastern and South African Telegraph Company's line.

ESSAYS.—A prize valued at over £100 is offered by the Royal Italian Scientific Institute of Venice for the best essay on "The Hypotheses Recently Advanced on the Causes of the Phenomena of Light, Heat, Electricity, and Magnetism." Essays to be sent in by the 31st of March, 1883.

ELECTRIC LIGHT AT DEWSBURY (YORKS.).—The electric light was successfully introduced into Dewsbury the other night by Messrs. Crompton and Co. The Market Place and its approaches were illuminated. Additional lights are, however, to be placed in Church-street and Upper and Lower Westgate.

ELECTRIC LIGHTING FOR CAPE TOWN.—The Cape Town Municipality are inviting tenders for lighting the town by gas, lime, electric light, or other illuminating power. Plans of the town and other information can be obtained at the South African Loan, Mortgage, and Mercantile Agency, 9, King William-street, E.C.

A NEW USE FOR SECONDARY BATTERIES.—Somebody, not an electrician, has suggested that Faure batteries should be connected with lightning rods to accumulate the electricity in a thunderstorm. We recommend Mr. Somebody to consult his electrical books, or make experiments himself before he ventures to "suggest" in future.

SUBMARINE TELEPHONE LINES.—Successful experiments are stated to have taken place on the south-west coast of France with the telephone connected to a short cable. The Island of Aix, St. Pierre d'Oleron, and other places were connected by telephones by means of a submarine cable, and the results are said to have been quite satisfactory.

CHANNEL CABLES.—The Boulogne, Dieppe, and Calais cables, have at length been repaired, and the Submarine Telegraph Company's vessel, the "Lady Carmichael," left Dover on Tuesday, the 27th inst., for the North Sea to restore the North German cable, which was damaged in the early part of October. She is in charge of Mr. Bordeaux.

CABLE REPAIRED.—With reference to the repair of the Paris-New York Company's cable, noted in our last week's issue, we are informed that the work of repairing was undertaken by the company's cable ship "Pouyer-Quertier," Captain Stuart Fossardy, and was successfully carried out under the direction of Mr. Julius Ebel, the company's engineer.

ELECTRIC LIGHT IN MANCHESTER.—On the occasion of the recent visit of the Dukes of Albany and Edinburgh to Manchester the front of Messrs. Lewis's large establishment in Market-street was brilliantly illuminated by a number of electric lights. Messrs. Lewis have for some time past employed this means of lighting, but the number of the lamps in ordinary use was largely increased for the occasion.

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Overhead Wires and Lightning.—Dr. Stephan, of the Imperial Postal and Telegraph Department in Germany, has lately given it as his opinion, in answer to inquiries by the Magdeburg Fire Insurance Company, that if proper precautions be taken in arranging telephone lines to provide a sufficient path for atmospheric electricity to earth, the wires might even afford protection to houses over which they pass.

Electrical Society of Melbourne.—The *Melbourne Age* of the 4th November says:—"The Telegraph Electrical Society held their monthly meeting at the Athenæum on Wednesday evening. Three new members were elected, and one proposed. An instructive evening was spent in testing various forms of batteries, with a double coil Duprez galvanometer, this being a new form of this instrument specially designed for this purpose."

The Electric Light for Emergencies.—The large tool shop belonging to Messrs. Fowler's engine works at Leeds was burnt down a few days ago. Messrs. Fowler at once telegraphed to Messrs. Hammond and Co. to erect some of the Brush lights to enable the *debris* to be cleared away by night as well as day. Within forty-eight hours the ruins were illuminated, and we believe the light is to be used until the buildings have been re-erected.

The Scilly Cable.—The repair of this cable was successfully accomplished by the ss. "Morna" on Christmas Day. The operation was conducted under the supervision of Mr. Lumsden. This cable has been broken for nearly six months. The "Morna" has had some difficulty in getting to work, owing to the stormy weather, and once she was obliged to run to Falmouth for shelter. The cable was found to be broken some twenty miles from the Cornwall end.

The Telephone at Bradford (Yorks).—At a recent monthly meeting of the Bradford Chamber of Commerce a deputation attended from the National Telephone Company to give information as to the arrangements which the company are making with the view of bringing the telephone into requisition for commercial purposes. The deputation urged the Chamber to move the Postmaster-General to remove the existing restrictions on the use of the telephone.

The Electric Light on Railway Engines.—The Northern Railway of France has adopted an electric head light for their engines, in place of the ordinary oil lamp. The current is produced by a machine worked by the engine itself. The light is said to be very successful, and by its aid trains may be seen approaching at a much greater distance than was previously the case. Not long ago we gave an account of a similar head light which was in use on the Austrian railways.

The Telephone and Fires in Birmingham.—In consequence of the terrible disaster at Vienna, a special inspection has been made of the theatres and concert halls in Birmingham by Superintendent Tozer, the head of the fire brigade, with a view of ascertaining the danger to be apprehended under circumstances of an alarm of fire. In his report on the subject to the Watch Committee, amongst other things, he strongly recommends that there should be telephonic communication with the central fire stations.

Opening of New Telegraph Stations in China.—With reference to the note on this subject in our issue of last week we are now informed by the Great Northern Telegraph Company that, the Chinese Telegraphic Administration having foregone the seven words minimum land line charges, the fixed charges from this country to the undermentioned places will be as follow:—For Soochow, 9s. 2d.; Chinkiang, 9s. 3d.; Tientsin, 9s. 7d. per word. There is a daily mail between Tientsin and Peking, leaving Tientsin at 3 p.m. and Peking at 4 p.m. Time of transmission twenty-four hours. Postage 10d. per message.

The Electric Light at the Savoy Theatre.—On Wednesday, December 28, 1881, for the first time in the history of the electric light, a theatre was by its means lighted throughout. The thanks of playgoers must be given to Mr. R. D'Oyley Carte for the enterprise he has shown in adopting this cool and wholesome luminant to light his new Savoy Theatre. We had previously witnessed a rehearsal of the lighting experiment, and felt quite sure of its success practically. The lighting has been carried out by Messrs. Siemens, who have six of their alternate current machines, driven by two of Fowler's engines, to generate the current for some 1,200 Swan lamps. Full details will be given in our next issue.

Electrical Railways.—A letter on this subject appeared in *The Times* of the 27th inst. from Professors Ayrton and Perry. The object of the letter is to show that electricity can be used to transmit energy to trains over a line of 200 miles in length, this line being divided into sections, insulated from one another, and so arranged in connection with the train that it is a sheer impossibility for two trains to run on the same section at the same time. The letter also describes "How the clerk in London will see before him on a map of the railway a series of moving black shadows, each of which indicates the position and motion of a train." Two lectures are shortly to be delivered on this subject by the professors at the London Institution and Royal Institution.

An Electric Buoy.—A daily contemporary states that experiments are being made in the Lower Bay, New York, with a new electric buoy, the invention of Mr. Bigler, of Newburg. Mr. Bigler, it appears, owns the patent of the old Courtney Whistle Buoy, the principle of which he combines with an intermittent light, the same power which blows the whistle being used to generate the electricity that furnishes the light. The rise and fall of the waves compresses the air inside the buoy. When this pressure has reached a certain point, it works a dynamo machine and burner furnished by the Edison Electric Light Company. This machine is supposed to generate enough electricity to show an intermittent light. When the pressure is exhausted by the action of the machine, which makes about 300 revolutions per minute, the light goes out until the pressure is renewed by the motion of the waves. The more violent the waves the more powerful the light, up to a certain point. Thus the light is at its brightest during a hurricane.

Mayrhofer's Pneumatic Clocks.—Mr. Mayrhofer, whose system of pneumatic clocks has for some time past been working in Vienna and Paris, is now in London, arranging for the introduction of his system here. He has made some improvements, which consist chiefly in employing electric currents in connection with the pneumatic system. In the new system the clocks of a city will not stop in the case of the breaking of a pipe, stoppage of a central clock, or other accident, as every clock is now supplied with works of its own, and will continue to go—for fourteen days or more—when once wound up and set in motion. They receive every hour, or at even longer intervals, an impulse coming from the electro-pneumatic relay, by which they are at the same time regulated and further wound up for the amount of one hour; and in case this impulse, by accident, should not arrive, they will nevertheless continue to go without interruption. This peculiarity secures for the new system the possibility of being applied over a much larger area.

Draining Mexican Marshes by Electricity.—The most extensive application of electricity to engineering ever

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made will be the plan of Mr. Maxim, of New York, for draining the basin around the City of Mexico, to do which a company has been formed, the funds raised, and the contracts signed. The plan, in brief, is to establish on the western slope of the mountains, where the fall is great and rapid, a number of water wheels, sufficient to develop some 20,000 horse-power, and make them drive dynamo-electric machines of high electromotive power. The current from these machines is to be conducted about twenty miles to a set of electric motors placed on the margin of the lake, and driving pumps which will require about 7,000 horse-power to work them. The water has to be raised about 40ft. to clear the ridge, but, once raised, it has uninterrupted fall toward the Pacific of several thousand feet, so that the descending water is made to keep up the work. The whole apparatus constitutes what Mr. Maxim calls an "electric syphon." The plan will, it is believed, succeed, and thus relieve Mexico from the inundations that have submerged it so much for several centuries.—*Engineering News*, New York.

Telephonic Noises.—*La Lumière Electrique* says:—"M. Ader has lately made some fresh observations on this subject as follow:—If one or two telephone receivers be placed in a circuit, and a new file be placed on one of the wires, and if at the same time it be rubbed with a piece of iron attached to the second wire nothing will be heard as a rule; if, however, the file be magnetised, marked sounds will at once be heard, and, what is yet more curious, these sounds will be noticed when copper is used as a rubber. If the file be heated the sounds become much louder. The heating may be produced by the action of rubbing itself or by other means, which may, perhaps, serve to indicate that a thermo-electric action accompanies this class of phenomena. The friction of copper against copper, or iron against iron, and generally any two pieces of the same metal, causes no appreciable sound, but if the end of one of the telephone wires be terminated by a heated copper plate and the other by an iron plate, marked sounds will be heard in the telephones at each contact between the two plates, which cannot be done when they do not differ in temperature. In this case even percussion produces no results. If, instead of heating them, we interpolate a damp intermediary between the two plates, such as water, sounds will be heard at the moment of the contact, but it is necessary that the metals should be of a different nature or no results will follow."

A Photometric Balance.—A simple form of photometric balance has been invented by M. Coulon, who calls it an *athermanous* photometer, as being acted on only by luminous rays. Its principle is that a radiometer, whose temperature is constant, turns solely under the influence of light. The apparatus consists of a radiometer bulb fixed in the middle of a cube-shaped metallic case, having four lateral apertures closed with glass, through two of which light can be sent horizontally, traversing the bulb, while the two others allow observation of the bulb. The case is filled with water, which, through four vertical tubes, screened from the bulb, and surmounting spirit lamps, is heated to a temperature above that of the radiant heat of the sources to be measured—in practice about 100deg. suffices. The bulb contains, *in vacuo*, a disc movable round a vertical axis, the half disc on one side of this axis being black on its two faces, the other white. When a single source of light acts on the bulb from one side it attracts the white half and repels the black, so that the disc turns edgewise to the light, and presents one side to the observer. If another equal light act simultaneously on the other side, and at the same distance as the first, the counteraction results in the disc presenting its sides to the light, its edge to the observer. Where unequal lights are compared one may always, by shifting one of them, bring the disc into the second position just specified, and by then measuring the distances ascertain the ratio of the intensities.

The Principle of Mutual Accumulation.—Dr. Paget Higgs writes to the *Scientific American* for the 10th inst., under the above title, as follows:—"In the issue of your supplement, date of November 19, appears a special article by Dr. Gustave Glaser. This article contains some historical remarks that I am sure you, with the usual American desire to give every man a fair hearing, will allow me to object to. Dr. Glaser offers therein what he is pleased to think unimpeachable evidence of the prior right of Dr. Werner Siemens to the discovery of the principle of 'mutual accumulation' in dynamo-electric machines. But Dr. Glaser is too evidently biased. He does not accord to Sir Charles Wheatstone that proportion of a great discovery which he accords to Dr. Werner Siemens, unwittingly thereby paying Sir Charles the greater compliment, since he acknowledges a difference only of a month in publication. Now, sir, I have had the honour of having been chief assistant to Sir Charles Wheatstone for a considerable period, and the greater honour by hard work to have been placed in close familiarity with so eminent a man of science, who was pleased to show me, many years before this claim of German priority became so pressing, the notes of his experiments on this principle of 'mutual accumulation,' made several years before publication. Before his death, however, Sir Charles told me that he believed that priority was really due to Hjorth, the Swedish electrician. As Sir Charles Wheatstone has been dead some years, I have, of course, no personal interest other than that due to the memory of an old master in claiming for him the priority due to him, except it be a new version of the trite saying, 'Dead men can tell no tales' (for themselves). Dr. Glaser says:—'By a comparison of both lectures it is plain to see that Mr. Wheatstone mentions nothing that had not been said six weeks before publicly by Dr. Werner Siemens in Germany.' There is, sir, a great deal, which even the Dr. C. William Siemens, of London, is good enough to acknowledge in his paper read before the Royal Society recently on March 4, 1880."

Electric Lighting at the Smoke Abatement Exhibition.—Several systems of electric lighting are being shown at the Smoke Abatement Exhibition, now being held in the buildings adjoining the Albert Hall, South Kensington. Messrs. Siemens Bros. have some Swan incandescent lamps running, fed by one of their upright dynamos, which in turn is driven by one of Crossley Bros. "Otto" gas engines, supplied with gas from a Dowson economic gas producer. This exhibit i one of the best combinations of gas and electricity that have been seen for some time. It is stated that the Dowson gas producer will make gas at a cost of only 3d. per 1,000 cubic feet. The producer is connected with a holder, which, of course, can be of almost any capacity. It would be interesting to know what would be the cost of running a certain number of incandescent lights, with a dynamo machine driven by a gas engine, fed from one of the Dowson producers. No doubt our readers will be able to see some such combination as that now shown at Kensington at the Crystal Palace Exhibition, as we notice that the Dowson Economic Gas Company (it was misprinted *Dawson* in our recent list of exhibitors) are to exhibit their apparatus there. In addition to the Swan lights, we believe that Messrs. Siemens are to show Dr. Siemens's method of melting iron by means of the electric arc in a furnace of his construction. It is

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stated that in practice a current of 100 webers, having a resistance of 50 ohms, and representing six horse-power of energy, will melt 1·5 kilogram of steel in a quarter of an hour in a hot crucible. A model of the Siemens electrical railway, which has become so well known lately, is also to be shown. Mr. Crompton will be represented by his arc lamp, which will be fed by a Bürgin machine, driven by one of Clerk's gas engines, made by Messrs. Thomson, Sterne and Co., of Glasgow, and recently described and illustrated in these columns (*Electrician*, Vol. VII., p. 393). The same engine and dynamo will also run several of Edison's incandescent lamps, which have been fixed up in the neighbourhood, some pendant, and some fixed like gas brackets, which are shown by Mr. Johnson, of Holborn Viaduct, Mr. Edison's agent in England. An Edison dynamo machine is also shown. Messrs. Rowatt and Fyfe were to have been represented by the Pilsen lamp, fed by a Schuckert machine; but, on the occasion of our last visit to the Exhibition, their apparatus, however, was not yet in place.

Society of Arts.—On Wednesday last Mr. W. H. Preece, F.R.S., delivered the first of his Christmas series of juvenile lectures, on "The Wonders of Electricity," at the above society. The hall was lighted by Edison lamps attached to brackets in pairs on the four sides of the room, and also by similar lamps inserted in glass blue-bells and white ones springing out of a handsome piece of metal work in imitation of a basket of flowers, suspended from the ceiling, and lent for the occasion by Messrs. Verity, of King-street. The lecture was illustrated by experiments. Mr. Preece began by explaining what was meant by "work" and "energy," and how in every case of the fatigue of one body something went out of it into other bodies. That something was energy, or the capacity for doing work, and it was a measurable quantity found in various forms, such as mechanical motion, chemical action, sound, light, heat, magnetism, and electricity. He showed the various ways in which energy was transferred by waves of liquid, of air, and of ether, and explained how the conveyance of electricity was affected by the properties of different substances, that were classed as conductors and insulators. The production of electricity by means of a battery was fully described, and the principal effect of electricity—viz., the production of electro-magnetism—was illustrated by a very large electro-magnet, a common poker, and an ordinary electro-magnet, the latter being built up before the audience. This principle, as applied to house bells, burglar alarms, fire alarms, and other purposes, was practically illustrated. The application of electro-magnetism to telegraphic purposes was then explained, also duplex and quadruplex telegraphy, and the Wheatstone automatic apparatus. The growth of telegraphy in this country was illustrated by a comparison between the years of 1869 and 1881. In those years the messages had increased from 6,000,000 to 30,000,000, the offices open from 2,000 to 5,500, and the income earned from £700,000 to £1,600,000. Submarine telegraphy in the same period had increased from a few miles up to 70,000 miles of wire, by which the globe is now encircled. There are now 803 newspapers and clubs receiving news, and there are 326 towns which daily receive intelligence from London. The applications of electricity to railway signalling, block signals, &c., and to telephones were also shown. Two tunes were played at a distant part of the building entirely cut off from the room, and they were distinctly heard by the audience through the telephone. The method of punching messages, and sending and receiving them by the Wheatstone instruments was shown at the conclusion of the lecture.

Two Ways of Measuring Energy.—In the *Journal de Physique* M. A. Potier gives two methods of measuring the energy expended by an electrical apparatus. First: Let V^1 and V^2 be the potentials at the two terminals of any circuit comprising a lamp, electro-magnets, and an electrolyte, and traversed by a current, i, of variable intensity, but periodical; let R be a known resistance, not liable to be influenced by induction—for instance, a wire wound round itself, inserted as an addition to the above circuit; and let V be the potential of the other extremity of this additional resistance. Joubert's method gives the mean value of $(V - V^2)^2$, or of $\int (V - V^2)^2 \, dt$, as $V = V^1 + R\,i$. This method gives us

$$\int (V^1 - V^2 + R\,i)^2 \, dt,$$

$$\int = (V^1 - V^2)^2 \, dt + 2R \int i\,(V^1 - V^2)\, dt + R^2 \int i^2 \, dt.$$

If we make three experiments, giving i the same value, and R the values 0, R^1, R^2, we shall be able to determine the coefficients of R and R^2, that is to say, firstly, $\int i\,(V^1 - V^2)\, dt$, or the mean energy expended by the apparatus, and, secondly, $\int i^2 \, dt$, or the only mean by which can be expressed the intensity of currents of variable character. The experiments should be made thus:—The needle and a pair of the quadrants of the electrometer being connected with V^2, R will be made up of two distinct fractions, and the other pair of quadrants will be connected successively with the end of the first fraction of R, and finally with the extreme end of this resistance. Second: Let V^1 and V^2 be the potentials of the two points between which we wish to measure the energy expended, and R a resistance. In a preliminary experiment we connect the needle of a Thomson electrometer with the potential V^2, the quadrants with the potentials V^1 and V. The beat of the electrometer measures

$$\int (V^1 - V)\left(V^2 - \frac{V^1 + V}{2}\right) dt.$$

In a second experiment we connect the needle and one pair of quadrants with the potential V^1, the other pair with potential V. The electrometer gives

$$\int \frac{(V^1 - V)^2}{2}\, dt.$$

The difference gives

$$\int (V^1 - V)\left(V^2 - \frac{V^1 + V}{2} - \frac{V^1 - V}{2}\right) dt = \int (V^1 - V)(V^2 - V^1)\, dt.$$

We have then at each instant

$$i = \frac{V^1 - V}{R};$$

accordingly, the last integral represents $R \int i\,(V^2 - V^1)\, dt$; from this we deduce the energy expended as $\int i\,(V^2 - V^1)$; we have further

$$\int \frac{(V^1 - V)^2}{2}\, dt, \quad \text{or} \quad R^2 \int i^2 \, dt.$$

Thus we do not obtain $\int (V^2 - V^1)^2 \, dt$, as does M. Joubert, but two other integrals which have a better determined physical character; the energy is deduced from two measures instead of three, and we may choose R of such a character that $R^2 \int i^2 \, dt$ shall be small by comparison with $R \int i\,(V^2 - V^1) dt$, at the same time that that is susceptible of accurate measurement. It is understood that the integrals represent the mean value of the quantities under the sign $\int$ during a period.

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CORRESPONDENCE.

THE SOCIETY OF TELEGRAPH ENGINEERS, AND OF ELECTRICIANS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to see by your report of the annual meeting of this Society that the mode of electing its officers adopted, or, rather, repeated, this year did not escape animadversion. Two or three years ago the same thing was done, and the same complaint made, but with a difference. On the former occasion the President for the time being agreed that the precedent was a bad one, and if I recollect rightly some of the Council expressed the same opinion. The impression conveyed to members on that occasion was that the plan had been adopted through inadvertance. This year it seems the matter was debated in the Council, and a division decided that the number of nominations should be no more than the number of vacancies to be filled. One would very much like to know who took part in this discussion and division; but I suppose we may not ask. The President, however, left no room for doubt as to which way he voted, and he gave his reasons. The Council are better able to judge the fitness of persons to sit with them than are the general body of members; and these fit persons, it seems, are usually unwilling to be put in nomination if there is a risk of their being outvoted. This is the case for the Council. The case for the non-official part of the Society —if the general body of members may presume to call themselves part of it—is of a different kind altogether. They may admit what the Council says, yet disapprove of what the Council does. The President added that if the members were dissatisfied they could, of course, get the rule altered. It is by no means certain that they could, even if they wanted. But they do not want the rule altered; they want it acted upon. As a legal question, the construction of the rule would turn upon whether the literal wording might be followed, or whether the intention of its framers must be followed. There is no doubt that the intention was to give the members a voice in the election of a proportion of the Council; and presumably also to give them ample time to make their choice. The Council deliberately thwart both these provisions by delaying the sending out of the nomination papers till almost the eve of the election, and then only naming three persons for the three vacancies. If the councils of other societies do likewise they are decidedly in the wrong if their rule is the same as ours. Could it be shown that it was framed in error, and that experience proves it to be unworkable, the members probably would offer no serious opposition to a proposal for amending the rule. But such a proposal should come from the Council itself, not from the members. So long as the rule remains what it is, it should be carried out in its integrity; and I cannot help thinking that it would be more dignified on the part of the Council, more agreeable to their own sense of propriety, to face the inconveniences—whatever they may be—of an appeal to the members, rather than resort to what everybody must characterise as an evasion.—Yours, &c.,

M. S. T. E.

Christmas, 1881.

THE STORAGE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Being tolerably well known to the paper makers of the United Kingdom, I have lately been inquiring indirectly as to the probability of utilising advantageously the present waste water power of paper mills in order to promote the storage of electricity, and I should be much obliged if you would allow me to make this announcement in your columns. Although the object of my inquiries has been necessarily veiled, the writer of the letter which I enclose has correctly interpreted my motive, and I will ask you to favour me by printing his letter also. It only remains for me to add that I shall be pleased to receive communications from any gentleman who may be willing to further the movement.—Yours, &c.,

RICHARD HERRING.

27, St. Mary's-road, Canonbury, N.

Dec. 27, 1881.

SIR: In further reply to yours of the 16th, I am only using 120 h.-p. of the water coming down this mill stream, which combines the waters of the Exe, the Creedy, and the Culm. In the autumn and winter months the volume of water running to waste is very great, and I have had an idea myself since the storage of electricity has been possible to utilise this waste power, as I am so well situated for water carriage to any part of the world. Barges can load here and have access to Exeter through the canal, or load vessels at Exeter, Teignmouth, Plymouth, Exmouth, &c. In the spring of the year I bought some shares in an electric lighting company, and have been watching events since. If your object has anything to do with my views, I should be happy to meet you on the matter. It would have to be undertaken by a company, as the capital and risk would be too large for private enterprise, but I am satisfied it would answer, as electricity must be the coming want of the age.—Yours, &c.,

Richard Herring, Esq. H. M. MARTYN.

THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.*

(*Continued from page* 87.)

VI.—*Thermal Actions.—Joule's Law.*

Heat is inevitably produced by the passage of an electric current, and Joule has shown by experiment that the quantity of heat developed in a circuit is expressed by

$$Q = I^2 R$$

where Q is the heat produced, I the intensity of the current, and R the resistance of the circuit.

This remarkable law could have been foreseen. It is a consequence of Faraday's law—Sec. I., par. (*a*), and the law of the conservation of energy, as we shall see. Remark first, that in a circuit where the current is entirely employed in producing heat, the heat produced is proportionate to the total quantity of zinc dissolved in the battery, that heat being only the reproduction, under another form of the work of chemical affinity, according to the principle of the conservation of energy.

Let us take, then, various circuits, and see how the total quantity of zinc dissolved will vary in them. In the first series let the resistances be kept constant and the intensities varied. To form a table of what passes in each circuit it is necessary to remember:—

1. Ohm's law, that the intensity is given by the ratio $I = \frac{E}{R}$. Since E is proportional to the number of elements we simply take this number to represent E.

2. Faraday's law, that the chemical action in each element is proportional to the intensity. The unit adopted being indifferent we take the value of the intensity to represent the chemical action, or the quantity of zinc dissolved in each element.

3. The total quantity dissolved is equal to the product of the number of elements by the quantity dissolved in each.

From these considerations we get the following table:—

No. of cells in battery.	Resistance of circuit.	Intensity of current resulting from formula $\frac{E}{R}$	Zinc dissolved in each cell proportionally to the intensity.	Total zinc dissolved.
1	1	1	1	1
2	1	2	2	$4 = (2 \times 2)$
3	1	3	3	$9 = (3 \times 3)$
4	1	4	4	$16 = (4 \times 4)$

In these conditions the total quantity of zinc burned, or the heat produced, therefore, is proportional to the square of the intensity of current.

* An article by M. Marcel Deprez in *La Lumière Electrique*.

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In a second series of circuits where the resistances are varied and the intensity kept constant we find :—

No. of cells in battery.	Resistance of circuit.	Intensity of current resulting from formula $\frac{G}{R}$	Zinc dissolved in each element proportionally to the intensity.	Total zinc dissolved.
1	1	1	1	$1 = (1 \times 1)$
2	2	1	1	$2 = (1 \times 2)$
3	3	1	1	$3 = (1 \times 3)$
4	4	1	1	$4 = (1 \times 4)$

Under these new conditions the quantity of zinc burned is proportional to the resistance.

Combining these two results, we see that in circuits where the resistance and intensity vary at the same time the quantity of zinc dissolved and heat produced is proportional at once to the square of the intensity and to the resistance, a result which leads us again to Joule's law $Q = I^2 R$. And remembering that $I = \frac{E}{R}$ by Ohm's lay, we have—

$$(a) \qquad Q = I^2 R = \frac{E^2}{R} = E \cdot I.$$

This formula, which applies to the whole of a circuit, is a particular case of a more general one. If we consider any portion soever of a circuit having a resistance r, and where the difference of potentials at the beginning and end of the circuit is e—Sec. II., par (*b*)—the quantity of heat developed in that portion of the circuit will be expressed by the formula

$$(b) \qquad q = r\, I^2 = \frac{e^2}{r} = e\, I.$$

It will be observed that no special notation is required to express I, since it has the same value in any part of the circuit.

Transport of Heat Energy.

To transport heat energy it is necessary to construct such a circuit as will collect the heat developed at one point and utilise it.

Consequently, in a circuit of total resistance R, traversed by a current of intensity I, a special portion of resistance r is taken, and the heat which manifests itself there is utilised. Under these conditions the work expended is equal to the total heat, Q, generated in the whole circuit, and the work collected is equal to the heat, q, generated in the useful part.

Calling E the electromotive force of the battery, we have the value of these two quantities from Sec. VI., par (*a*). Thus,

$$Q = R\, I^2 = E\, I = \frac{E^2}{R},$$

and, similarly,

$$(c) \qquad q = r\, I^2 = e\, I = \frac{e^2}{r}.$$

The ratio of these two works is $\frac{r}{R} = \frac{e}{E}$, that is, the economic yield.

The first expression $\frac{r}{R}$ is very useful, because it allows of immediately arranging a circuit so as to get the yield sought. It is obviously advantageous to make the useful resistance as great as possible, compared with the total resistance.

If we desire that the useful resistance q as well as the economic yield $\frac{r}{R}$ or $\frac{e}{E}$ remain constant whatever be the resistance, or, in other words, whatever be the distance of transport, it is necessary that q remain also constant. For this it is necessary that $\frac{E^2}{R}$ is constant, that is to say that E should vary proportionally to the square root of R, but as $\frac{e}{E}$ is constant, it is necessary that e should vary in the same proportion.

We are, therefore, for heat as for chemical energy conducted to the following laws :—

1. The positive heat work, representing the total heat expended, is expressed by E I; for a given intensity it is proportional to E.

2. The negative heat work is expressed by e I; for a given intensity it is proportional to e.

It should be remarked here that a difference of potential is only a distinct quantity of what we call electromotive force. In reality we do not recognise electromotive force, though it is convenient to use the word; only difference of potential enters into calculations. Consequently, in the law which we formulated in paragraph 2, the difference of potential is nothing but a negative electromotive force—if we would consider it so—and this law, though expressed otherwise, is nevertheless the same as that which we have found for chemical action.

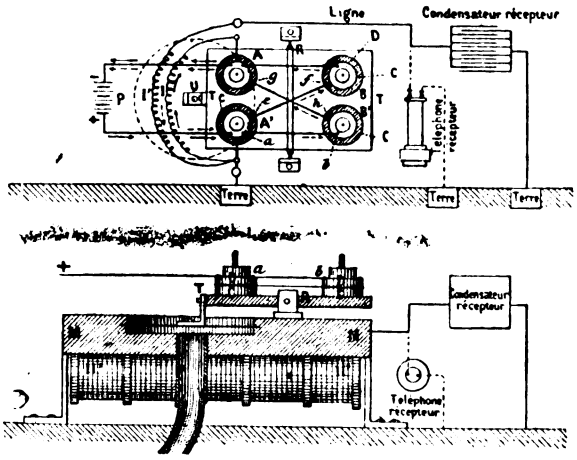
3. The economic yield is represented by the ratio of the difference of negative potentials to the positive electromotive force.

4. The heat work expended, the useful heat work and the economic yield remain constant, whatever be the distance of transport, provided that the positive electromotive force and the negative difference of potential vary proportionally to the square root of the total resistance of the circuit.

(TO BE CONTINUED.)

HERZ'S TELEPHONE SYSTEMS.*

In an article published in this paper on the 5th of Feburary last† on the telephonic apparatus of Dr. Herz, I deferred a description of his most recent systems to a future date. I deem the present an opportune moment for describing them. I would notice that his first system was based upon a novel and ingenious use of shunts. This necessitated the use of strong batteries, which were found to be inconvenient on long lines. And it was the use of telephones on long lines that Dr. Herz was aiming at. He thought at first of employing reversed currents, as in telegraphy; but how was he to do this in systems based on the use of transmitters of sonorous vibrations? He might have solved the problem by utilising the secondary currents of an induction coil, like Gray, Edison, &c., but then he would have lost the benefit afforded by the shunts in increasing the variation of pressure in the microphones. He then thought of increasing the effects of the induced currents themselves by prolonging their duration, or by combining them in such a way that they would follow two by two in the same sense or direction, and this is how he solved the problem.



I should mention that in his first experiments Dr. Herz ascertained that good results accrued from using microphonic contact pieces constructed of discs of carbon or other bad conductors laid one upon the other. He tried them in various ways, and found that a horizontal arrangement gave the best effects. Let us suppose, then, that four sets of these contact pieces are arranged at the four corners of an ebonite disc, C C, as A, A′, and B, B′, in Figs. 1 and 2, and that they are connected as shown, that is, the upper discs e, g, f, h, in parallel lines with the sides of the plate of the lower discs A A′, B B′, diagonally. Let us also suppose that the plate is balanced on an axis, R, that the discs are traversed by small pins fixed in the ebonite disc, and that the small leaden discs touch the upper discs. The plate should be connected at one end to a telephonic diaphragm by a rod, T. It will be at once understood that the vibrations of the diaphragm will consequently cause the plate to oscillate, and that this will produce two effects in the discs which will succeed each other. The first, viz., ascending vibrations, will cause an increase of pressure amongst the discs on the left side by reason of their *vis inertia* aided by that of the leaden discs. The

* Abstracted from an article by M. le Comte du Moncel in *La Lumière Electrique*, 5th October, 1881.

† This was reproduced in *The Electrician*, Vol. VI., pp. 192 and 204.

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second, for the same reason, will produce a decrease of pressure in the right hand discs, which will be expressed by a rebounding motion at the moment when the character or direction of the vibratory movements is changed.

If a current from a battery P traverses all the discs by the connections indicated above, and also the primary helix (by wire I) of an induction coil H H′, shown in the second figure, placed under the apparatus; and the secondary current of this coil be connected by wire I′ to line, in which is a telephone or speaking condenser, we shall find that, at the time of the ascending vibrations, an inverse induced current is produced which will immediately be followed by a direct induced current, which, being reversed by the cruciform connections of the discs, will continue the action of the first current, or will increase its duration, and, as a consequence, its effect on the telephonic receiver.

The results obtained with this system are very good. M. Herz has, however, endeavoured to simplify it. Many arrangements have been tried. For instance, to reverse the current, one contact piece only has been placed at each side of the vibrating plate, and though the movements of this plate were not of the nature of ordinary sonorous vibrations, they could be thought of as having different characters at its two sides, one contact piece being compressed whilst the other was expanded. This arrangement made it obligatory that the plate should be vertical in order to equally adjust the regulation of the two contact pieces, which should be identical. It became difficult to regulate by weight, and finally this was accomplished by using two parallel diaphragms, vibrating in unison, and each carrying its contact-piece, but in an opposite direction. The horizontal arrangement was reverted to, but with a happy combination of Dr. Herz's two systems, of shunts, and reversing. The current was led to a double contact-piece, where it was divided, and this contact was placed beneath a plate in such a way that its two points, of variable resistance, acted inversely the one on the other; or, in some apparatus, one point was made invariable and was acted on by the other. The result is easy of conception. Various arrangements have likewise been experimented with. In some the shunt is a simple one, that is one of the currents only is sent to line; in others it is double, each of its branches being connected to a coil and a receiver. In this case the results are very good, but the apparatus is somewhat complicated; it also necessitates great care in the construction, experience having shown that the resistances of the induction coils are not necessarily equal.

It should be added that the experiments were continued to ascertain the best substances for the microphonic contact-pieces. The list has been greatly extended by these researches, which have proved that an almost numberless quantity of substances can be used. The Herz contact-pieces are made of conducting bodies (such as metals) reduced to powder, and chemically combined by a kind of non-conducting cement. The proportions of the various elements depend solely on the conductivity of the materials used, and alone determine the microphonic value of the composition; their nature scarcely seems to exercise any influence at all.

The speaking condenser, so useful in preserving the effects of induction, has not, meanwhile, been neglected. Attempts are being made to ascertain a convenient mode of arrangement and construction, the successful working of these apparatuses being closely connected with the care with which they are placed in position, &c.

According to Dr. Herz, the telephone should not remain a unique apparatus, varying only in form; it should, on the contrary, be thoroughly modified according to the work for which it is destined. He thinks that a telephone for use over long distances should differ from a telephone for use in town exchanges, that one constructed to transmit song should not be precisely similar to one which transmits speech. He is endeavouring to produce instruments appropriate to each of these different uses.

THE CHANNEL CABLES.

Several letters on the subject of the broken cables in the English Channel have appeared in *The Times* of recent dates. As they have a more than passing interest, we reproduce them in the order of their appearance in that paper.

M. D. Colaco Osorio, of 84, Rue de Provence, Paris, began the correspondence as follows*:—

"Will you allow me to draw public attention to the defective telegraph communication between London and Paris? It is stated here that of the four cables (Havre, Dieppe, Boulogne, and Calais) only one is in tolerable working condition, while one has been interrupted for a fortnight, and two have been broken several months. Evidently the one cable is so badly overworked that telegrams take three to four hours to arrive, which virtually means that all regular business communication between the two most important markets is totally stopped. The French Administration say that they are not responsible that the two broken cables were not repaired before the third broke also. If the Submarine Telegraph Company neither is responsible, where have the public to look for redress?"

Mr. S. M. Clare, the Secretary of the Submarine Telegraph Company, wrote in answer to the above:—*

"With reference to a letter in your City article of this day's date, complaining of the 'defective telegraph communication between London and Paris,' I beg to state the following facts: During a gale in the English Channel on the 28th of November last the cables between Calais and Dover and Boulogne and Dover were broken by the dragging of the anchors of a large dismasted ship, which eventually got safely into Calais harbour. The cable between Dieppe and Beachy Head was broken on the 10th of December. The cause of this injury is unknown. On the 11th of December the Boulogne cable was repaired, but two out of the six conducting wires are still defective, and require further inspection. The steamer belonging to the company is at Newhaven waiting the opportunity of fair weather to repair the Dieppe cable, for, as you are doubtless aware, submarine cables can only be raised to the surface in a calm sea. As soon as the Dieppe cable is joined up the company's engineer will proceed to repair the Calais cable and cut out the faults in the two wires of the Boulogne cable, but none of these operations can be effected in rough weather. At present the telegraph service between France and England is carried on by means of four wires in the Boulogne cable and six wires in the Havre cable. It is therefore evident that the statement of your correspondent 'that out of four cables only one is in tolerable working condition, while one has been broken a fortnight, and two have been broken several months' is most inaccurate. Unfortunately, however, the late severe gales have not only injured the submarine cables but have blown down many of the land wires in connection with them on both sides of the Channel, which belong to and are maintained by the French and English Postal Departments. On the 19th of December five wires between Boulogne and Paris were broken, and seven wires near Beachy Head were blown down. On the 20th of December only one land wire between Boulogne and Paris was available for the transmission of English telegrams, and the fall of a tree between Cape Antifer and Havre interrupted the land communication with Paris *vid* the Havre cable. Neither the French nor the English Government is responsible for the repair of the cables in the Channel, although they are responsible for the maintenance and repairs of the land wires in connection with these cables; but I should like to ask your correspondent if he considers either the two Governments or the Submarine Telegraph Company responsible for the recent storms, which have occasioned far greater injury to commercial interests than a temporary interference with the regular transmission of telegrams between Paris and London?"

The correspondence was continued by an "Electrician," who said:—†

"The remarks in your City article and the letter from Paris published in that article yesterday have at last procured us some information from the Submarine Telegraph Company. It appears that, in addition to the cables already known to be broken, another was interrupted on the 10th of December, making six cables, containing in all 28 wires. Of these, one cable—the Boulogne—was partially repaired on the 11th of December, four wires out of six having been put in order. This, therefore, leaves 24 wires still broken down. No wonder that you have been several times compelled, in the public interest, to insist upon attention being given to the distressing irregularities and delays consequent upon the long-continued defective condition of telegraphic communications. The importance of a thorough ventilation of this subject is apparent from the discouraging circumstance that the wires put out of use have been constantly increasing in number owing, in great part, to the permanent insufficiency of the provision made for the restoration of the cables; thus the German Union cable was broken early in October, the Reuter on the 28th of October, the Dutch on the 13th of November, the Boulogne on the 28th of November, the Calais on the same date, and the Dieppe on the 10th of this month. Up to the present time only one of these cables has been repaired, and that only partially. The delay in repairing the North Sea cables, it is only fair to admit, was in the main owing during November to the obstacles interposed by the fishing fleet; but no measures were adopted to endeavour to avert these obstacles or to overcome them by introducing modifications in the method of working by the two ships on the spot. Since the early part of December, however, although the Submarine Company have had their ships ready for work in the British Channel, there has absolutely been no ship at all in the North Sea, because the Post Office has no ship, and has taken, apparently, no steps to procure one. The Submarine Company tells the public that the 'Lady Carmichael,' as the weather permits of the operations, will first undertake the repair of the "Dieppe" cable, then of the Calais cable, winding up with the repair of the two defective wires in the Boulogne cable. These repairs may be completed within a period more or less remote, 'as the weather permits,' and provided they are not further delayed by additional breakages. There is, and long has been in any case, work enough cut out for the 'Lady Carmichael' without going beyond the British Channel. But, Sir, what is the Postmaster-General going to do with the Reuter and the Dutch cables, the former broken down ever since last October, and forming a necessary part of one of the important trunk lines to India? Are the 5,000 miles and upwards of trunk lines between the German coast and India, with thier costly staff, plant, and machinery, to be kept idle and unemployed, and the public continue to be deprived of all direct communication by these cables with Germany and the East, as they have been for now nearly two months? Surely Mr. Fawcett's recognized capabilities must be strangely misunderstood by the public of this country if he will tolerate the continuance of a state of matters gravely reflecting upon the power of his department to cope with the present eminently unsatisfactory condition of our cable communications with foreign countries."

Mr. P. Carmichael, of 17, Fenchurch-street, E.C., in a subsequent issue‡ complained "that during the summer months, when stormy weather could not be pleaded as an excuse, telegrams sent by me to Paris early in the morning never reached their destination until late in the afternoon, thereby causing me in several instances material loss."

With reference to the above correspondence, we may state that the Boulogne, Dieppe, and Calais cables are now repaired, and that the Submarine Company's "Lady Carmichael" left Dover on Monday last to repair the North German cable.

* *Times* (money article), December 21.

* *Times* (money article), December 22. †December 24. ‡December 27.

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TO OUR READERS.

At the end of the year we have to look back with pleasure upon the assistance which our friends have continued to render us. We heartily thank them for their assistance, and at the same time desire it to be known that at all times we are glad to receive information relating to new inventions, or to electrical work being carried out. We trust also that the arrangements we have made for 1882 will meet with, if possible, a still greater share of support. Meanwhile, to each and all we wish a happy and prosperous New Year.

SUBMARINE CABLES.

The recent exceptional weather, causing, as it has, great damage to the various cables connecting England with the Continent, has also indirectly brought out a good deal of criticism upon cable management. The letters to *The Times* have been either reprinted or abstracted in our columns, and those who have kept themselves acquainted with the subject will have noticed the variety of opinions that have been expressed. Many letters have been written by men whose sole knowledge of the subject is contained in the one fact that, just at present, telegraphic messages cannot be sent off very rapidly. These men immediately indite a letter to *The Times*, or some other paper, and then and there lay down the law as it appears it should be to them. There is no argument sufficiently powerful to convince such men that they are really ignorant of the first principles of the subject, and that their ideas are both impracticable and ridiculous. We shall not attempt to consider the question in order to convince them, but rather to state the case as it appears to us, and to indicate the direction in which action should be taken to remedy the existing state of affairs.

A submarine telegraph cable is a costly article. It is subject to various actions which may interfere with its continuity, and, therefore, with its utility in performing the part in the telegraphic system it is intended to fulfill. The natural causes leading to faults are sufficiently numerous to tax the ingenuity of the management in their repair, and so costly as to generally form the principal item on the adverse side of the balance-sheet; but it is doubtful if these natural causes do as much damage as those which arise from ignorance, prejudice, or wilfully destructive action, all such damages being preventable. The types of cable vary greatly. Ordinarily a long cable is made up of a deep sea section, intermediate sections, and shore sections, the latter being made of great strength to resist the greater action of moving water in the shallower places, and also to resist any accidental contact with anchors, &c. The comparatively short cables connecting England with the Continent are designed even to have a superabundance of strength, and with the result that, generally, little fault has to be found with regard to interruptions. In landing the shore end of a cable the general rule is, whenever possible, to avoid anchorages. A selection of position has to be made, and it sometimes happens that what was a comparatively quiet spot at the time of selection becomes more and more frequented by vessels whose anchors jeopardise the existence of the cable. It can hardly be argued that the cable should be relaid in another spot because of this, for under such a condition of things cable companies would not be found ready to risk the capital required in such enterprises. A rule, almost axiomatic with the companies, is not to interfere with a cable after it is once laid, except in cases of absolute necessity. Some companies offer to repay the cost of anchor and tackle which accidentally fouls a cable if cut away without injury to the cable, and the majority of the companies would undoubtedly make any such loss good in preference to having to repair their cable. It will scarcely be credited that authentic instances—and of recent occurrence, too—are on record, in which a cable has been deliberately cut because fouled by the tackle. There is no comparison between the value of an anchor and the loss which occurs when a cable is cut. Communication has not been completely severed with the Continent, only made difficult because of the number of lines faulty, yet great inconvenience has resulted, and thus some idea may be gained of what would happen were communication completely stopped.

A fruitful source of danger in the shallow waters arises from the careless manner in which the trawls are mended. The remedy for this is fairly simple. Many of the fishing boats belong to wealthy companies, and it is in the interest of the companies themselves that the repairs to trawls should be made in the best possible manner. Revenue officers abound at most fishing stations, and a periodical inspection of the trawls by such an authority would probably be sufficient to obtain complete immunity from this source of danger. Of course we assume that the value of cable communication is such as to cause the various Governments to act in concert in this matter, and to agree to inflict a fine or in some manner punish those who persistently sin against the regulations laid down.

The cable companies do not expect any such system as has been suggested by a contemporary to be carried out. In fact, the plan is impossible. The idea we refer to is the compensation of the "first comers," the restriction of a certain distance from a cable as a kind of private property, and enforcement of penalties for trespass. Who are the first comers to whom compensation should be paid? We have always understood that the fishing rights on the high seas at

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a certain distance from the shores of each country are as free as the air we breathe. There is, however, but little new to discuss in this question, as the fishermen are not likely to be asked to give up any ground. They are asked to mend their trawls properly, and they are asked if, for a few hours once in a year, or once in ten years, they come across a repairing vessel, to consider that others have rights as well as themselves. Good communication is as necessary to civilisation as good fish. If, then, by the action of a storm, a cable is broken, and the repairing vessel puts down one, two, or three buoys for the purpose of marking the starting point of the dredging operation, or the buoyed end of the cable, it should be compulsory on the part of the fishermen not to interfere with these buoys, and by international agreement the rule should be stringently enforced. Surely it is no great hardship to ask for such restriction. The law of averages, or the doctrine of probabilities, will show that any given fisherman will not lose two hours' work in a lifetime under such a law, even when rigidly carried out.

When it is considered that the work of repairing cables depends to a great extent upon the weather, any slight boisterousness interfering considerably with such delicate work, we think the fishermen are not asked to give up too much. There are several other questions which greatly interest cable companies, such as the harbour and light dues, the transfer of cable from one vessel to another, and so on, which we cannot fully deal with in the present article. It seems, however, contrary to all ideas of justice that a cable vessel, waiting to repair a cable, going out of harbour whenever a favourable opportunity arises, and being driven back again and again by stress of weather, should have again and again to pay certain dues. The question of the transfer of cable from ship to ship is fairly stated in another column, and we shall refer to it at an early date.

UNDERGROUND WIRES IN NEW YORK.—News from America says that the Mayor of New York recently vetoed a resolution of the Board of Aldermen authorising the Metropolitan Telephone and Telegraph Company to lay their wires under the streets. His reasons are that the resolutions fail to make any provision for the payment to the city of any adequate consideration for the principle sought; also that the payment of one cent. per lineal foot of street occupied is scarcely more than nominal; only one wire in each route would be reserved for the use of the police and fire departments. A further objection is made that the company is only one of a large number who would claim the same right; and as the streets are now largely occupied by gas and water pipes, sewers, railroad foundations, &c., there would be no place, in many streets, for more than a few wires. It is further stated that such a privilege should only be granted after a careful consideration of the requirements of the entire telegraph system of the city, with a view to its future development.

AUSTRO-HUNGARIAN TELEGRAPHS.—According to statistics recently issued, the total length of lines in the Empire is 35,056¾, and of wires 91,712¼ kilometres, or an increase over the preceding year of 753 kilometres. The length of subterranean and submarine cables was 629¼ kilometres. There were 2,554 stations open, of which 1,147 belonged to the State, 1,310 to railways, and 97 to private individuals. The *employés* numbered 2,499, of which number 370 were women. There were in use by the State 1,830 Morse, 64 Hughes, and 5 multiplex instruments; the railways used 1,650 Morse instruments, and the private telegraphs of Vienna 143 more. The total number of telegrams sent over the Government lines in 1880 of all kinds was 5,296,315, or an increase over the preceding year of 275,950. The total receipts from the telegraphs of the State was 3,620,411fl., an increase of 517,243.

ELECTRIC LIGHTING BY WATER-POWER.*

BY THOMAS B. GRIERSON, ASSOC.I.C.E.I.

Whilst the subject of the revival of Irish manufactures is still uppermost in the minds of the people of this country, it may not be unadvisable to consider briefly some of the many ways in which we might utilise for industrial purposes the enormous water-power which Nature has placed so abundantly at our disposal.

One of the many purposes for which this water-power might be made available would be the driving of water-motors for the production of the electric light.

Many towns in Ireland, for instance, which at present are not lighted at all artificially, owing to the enormous first cost of a gas-works, as well as the high price of coal, or perhaps the number of would-be consumers being too small to pay working expenses, might, by utilising the water-power at their disposal, light their streets by electricity at a very small cost indeed.

That the electric light will, at all events, be the light of the near future for public thoroughfares, railway termini, and the lighting of large areas generally, few who have given the subject any consideration at all will deny—excepting, perhaps, those who being holders of "gas shares" are naturally interested for the success of gas lighting.

The question of *domestic* lighting by electricity can scarcely yet, however, be said to be sufficiently advanced to be pronounced an unqualified success, but much has been done, and is at present doing notwithstanding, towards the displacement of gas by electricity in our dwelling houses; and when we consider the immense number of patents which are taken out every month for lamps to accomplish this end, we may expect at no distant date to find a lamp devised which for softness, steadiness, and brilliancy has never yet been equalled.

The Swan lamp described below is an instance of a successful electric lamp for domestic lighting.

Dynamo-electric Machines.—Out of the very large number of dynamo-electric machines which have been constructed from time to time, and which have proved commercially successful, those of Siemens, Gramme, De Meritens, Maxim, Weston, and Brush have perhaps come most prominently to the front. Of these again the Siemens and the Brush machines appear to find most general favour in the electrical world—the latter being now perhaps *the most* popular of all, possibly on account of its having rendered the subdivision of the electric current a perfect success.

Although it is not the author's intention to enter into any lengthened detail of these various machines and systems—graphic descriptions of each of which have already been published in the technical journals of the day, as well as in the *Proceedings* of the Institution of Civil Engineers—yet a few observations upon the Brush machine and the Brush system of electric lighting, which, as was before observed, appears to be *the most* popular of all, may not be out of place. From an article which appeared in *Engineering* in January of the present year the following is an extract:—

"The Brush system of electric lighting which, during the last two years, has, in the United States of America, been developed into a very important commercial industry, is one of the most interesting systems of illuminating by electricity that has yet been before the public, and we are glad to see that it is at last becoming more and more appreciated in this country, and promises to take a leading position among the lighting systems of Europe."

That these machines, and, indeed, the whole system of lighting proposed by Mr. Brush, have succeeded in this country, and fully come up to the expectations of those who were responsible for their introduction, may be said to be due more to the fact that they contain within themselves the elements of success than that they have been the outcome of any great amount of "puffing," being, both practically and theoretically, well constructed.

Indeed, the workmanship of the machines is of such a high-class that the armature, although revolving at the great speed of 770 revolutions per minute, can be run almost touching the poles of the electro-magnets. And when we remember how difficult it is to make a ring without a *solid* boss and *solid* arms run perfectly true upon a shaft, our admiration of the workmanship is not lessened. Yet this is what has been done in the Brush dynamo-machines, the armature of which—and this is one of the salient points of the Brush system—consists of a cast-iron ring of a general rectangular cross section, having a number of projections on both its sides, which thus leave an equal number of radial recesses to receive the coils of wire, or bobbins, for generating the current. In the 16-light machine, which is the normal size, the armature is 20 inches in diameter by 5½ inches wide, on face, over all. The deep grooves are intended to prevent any cross currents being induced in the coils, or, in short, to cut off or insulate each opposite pair of coils from the remaining coils. They also have the effect of lessening the weight of the mass to be driven, as well as of increasing very largely the cooling surface; thus keeping down any tendency to heat in the coils which would cause a much greater resistance to the currents, and render the machine less effective. There are eight bobbins or coils of insulated copper wire (No. (14 B.W.G.) upon each armature, each coil containing about 900 lineal feet, or about 20lb. weight of wire. All the coils are wound in the same direction, but each opposite pair of coils are connected together on their inside by a wire running through the shaft across the diameter of the armature ring. Wires from the outer ends of these coils conveying the current are then carried along through the hollow driving-shaft to the commutators from which one half of the current is conveyed through one pair of brushes to the main circuit, and the other half by another pair of brushes to the electro-magnets, so that one coil of any pair in action feeds the main circuit, and of course the lamps, whilst the other and opposite coil feeds the machine itself, inducing polarity in the large horseshoe electro-magnets by which an intense magnetic field is produced, and within which field the armature revolves. This arrangement by which the one armature is made to do all the work—supplying the magnets and feeding the main circuit—may be said to be entirely unique; most of the other dynamo-electric machines requiring two—one to induce polarity in the magnets, and a second to feed the main line circuit.

The advantage of the Brush arrangement is obvious—less friction to be

* Read before the Institution of Civil Engineers, Ireland, at the annual general meeting at Trinity College, Dublin, 7th December, 1881.

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overcome, and, therefore, less power required for driving. There is another point about the Brush system deserving of mention, it is that when any pair of bobbins are in the vertical position they are then entirely insulated, which is a very great advantage, since in this position the bobbins being in the neutral portion of the magnetic field would, if they were not insulated, tend to reduce the unit potential, so to speak, in the whole machine, by absorbing some of the power without being able at the same time to generate any power in return. To this also may be due in some measure the coolness of the machine when running, because each pair of bobbins has a period of rest equal to one-fourth of each revolution, during which no current is running through them, or, in other words, that for 75 per cent. only of the time during which the machine may be running is there a current passing. There are a great many other good points about the Brush dynamo-electric machines well worthy of mention, but time would not permit the author to go into them.

The following table, for which the author is indebted to Mr. P. Jolin, the clever engineer of the Dublin Electric Light Company, may be found useful, as giving in a concise form some practical data respecting these machines:—

Number of Machine.	Estimated Candle Power per Light.	Number of Lights.	Indic. Horse-power required to Drive.	Revolutions per Minute.	Diameter of Pulley in Inches.	Width of Belt.	Approximate Weight of Machine in lbs.	Price.
								£
5*a*	3,000	4	6	900	10	5	1,150	240
5*b*	2,000	5 or 6	6	900	10	5	1,150	240
7*a*	2,000	10 to 18	9 to 14	770	14	8	2,200	400
7*b*	50,000	1	15	770	14	8	2,200	500
8	2,000	40	32	650	20	12	2,200	720

Lamps.—The two principles upon which electric lamps have as yet been constructed are:—

1st. Lamps in which the light is emitted from a continuous carbon rod, heated to incandescence by the resistance of the passing current; and, 2nd. Lamps in which the light is the result partly of the incandescence of two carbon points, and partly of the brightness of the electric arc induced between those points.

The Swan lamp before referred to, and which is intended more for domestic lighting, is constructed upon the first of these two principles, and consists of a hermetically sealed glass bottle, in which is secured, so as to hang centrally in the bottle, a fine wire of a special kind of carbon bent into the form of a spiral, the two ends being joined to copper wires which run up through an air-tight stopper in the neck of the bottle for connection with the poles of a battery or a dynamo-electro machine. The light emitted from this lamp is very soft and pleasing, and when a number of them are hung upon a suitable pendant they form a graceful and elegant chandelier.

To extinguish any of the lights, without stopping the machine, it is only necessary to lift off any particular lamp.

The inventor claims for this lamp great convenience, and states that the wires running through a house to convey the current for the lighting of the rooms might also be utilised to produce a light at any intermediate point in the circuit by simply hanging a lamp upon the wires wherever a light was required.

Subject to proper precautions for insulation the author believes there would be no great difficulty in applying such an arrangement in practice.

The Brush lamp used for large areas and street lighting is one of those in which the light is due in part to the incandescence of the carbon points, and also in part to the brilliancy of the continuous spark or electric arc maintained between them.

The great difficulty with lamps of this kind has heretofore been to keep the carbon points the proper distance apart, so as to preserve the steadiness of the light. The usual method adopted for securing this advantage was to feed the plus carbon down to the minus carbon by clockwork. This was the plan adopted by Siemens and others with varying, but never with what could be called positive success, owing to the difficulty of constructing mechanism which would work with absolute smoothness, as well as that of keeping the feed constant. There was also great difficulty in obtaining homogeneous carbons, it being frequently found that when a hard piece of grit occurred in one of the burning pencils it would fly off and leave a gap in the pencil with the effect of reducing the light very much, if not of extinguishing it for a time, until the slowly feeding carbon had again been brought down to the proper sparking distance, when, of course, the light would again blaze out. A vacancy or gap in the carbon would also produce pretty much the same effect.

The Brush Company, however, manufacture their own carbons, and have produced, in consequence, pencils which give very little trouble, they being almost perfectly homogeneous. It may be mentioned here that the carbons, before being used, are about 12 inches long by 7-16ths of an inch in diameter, and are electro-plated with a thin coating of copper. The cost of the carbons is about one-halfpenny per hour.

The method adopted for feeding the carbons in the Brush lamp is by making the lower or minus carbon fixed, and allowing the upper or plus carbon to descend by gravity only, its descent being controlled by two electro-magnets, inside of which two wrought-iron plungers are free to work up and down, the lower ends of these plungers being connected to a cross head having a forked end supporting an annular ring or washer, which encircles the plus carbon, and as the hole in the ring is somewhat larger in diameter than the pencil, it follows that if the ring be tilted out of level, it will have the effect of jamming the carbon, and thus preventing its further descent. When, therefore, the lamp is put into circuit the upper carbon descends until it touches the lower carbon, when the current being then continuous the carbons are almost immediately heated to a state of incandescence, the electric arc is established, and a blaze of light is the result. But should the upper carbon descend too rapidly or too far the resistance between the carbon points is reduced, while at the same time the resistance of the controlling electro-magnets is increased the latter "suck up" the soft iron plungers, and with them the lever which tilts and catches the annular ring, which latter jambs the carbon and brings it up along with it. To guard against the danger of drawing the upper carbon too far away from the lower carbon there is a second coil of very fine wire wound upon the first or primary coils of the controlling magnets, but in an opposite direction; in this coil a current is induced, which has a tendency to neutralise to a certain extent the current in the primary coils, and these two forces are so arranged that when the carbons are their proper distance apart, the electromotive force in the primary and heavier coil is somewhat the greater of the two, but should the carbons become injured or burnt out the current is then transmitted through the fine coils, which latter again being in connection with a third electro-magnet, shunts the current back into the main circuit, and every other lamp in the circuit utilises the extra electricity thus set free, by increasing its light—just as turning off a large gas jet will increase the light of all the others supplied by the same pipe.

This—the method by which the light is sub-divided—is the great feature of the Brush system, for in fact all the lamps on the same circuit are entirely independent of one another—each being practically automatic in its action from the starting of the machines until they are stopped, or the lamp carbons are burnt out.

It has been stated above that the carbons are intended to burn for eight hours—*i.e.*, a single carbon, but by a very simple arrangement a second, or even a third, carbon can be introduced, so as to make the light available for 16 or 24 hours if necessary, with the same arrangements of magnets as is required for the one carbon only. This is effected in the double carbon lamp by having a *double-forked* lever and *two* annular rings, one of which grips its carbon and holds it in position whilst the other is allowed to descend until they, the first pair of carbons, are burnt out, when the second pair of carbons start into action unaided to supply their place.

Having mentioned the difficulty of feeding the carbons by clockwork, and some of the vast improvements and ingenious contrivances of Brush, for dispensing with the same, it is obvious that this description would be incomplete if no reference were made to the Jablochkoff lamp, in which there is no system of feeding the carbons whatever.

When the Jablochkoff candles were first introduced into London a regular panic ensued amongst holders of gas shares, as it was believed that an immediate revolution was about to take place in street lighting.

However, gas has held its ground, and it is not unlikely that should it be superseded by electricity for street illumination, that it may be applied for many useful purposes to which it has never yet been put, possibly because it was not available.

The system upon which Mr. Jablochkoff, a Russian gentleman, constructed his "candle" lamp was to place the plus and minus carbons side by side with a "distance piece" of plaster of Paris between the two, the carbons being thus kept at their proper sparking distance—a most ingenious and simple arrangement.

When the current was "turned on" and the lamp came into action, both carbons and the plaster of Paris were all burned down together; but, owing to the fact that all plus carbons burn away about two-and-a-half times as fast as minus carbons, it was necessary to reverse the current at intervals, in order that both carbons should be preserved of an equal length, the reversing of the current causing the minus carbon to become for the time being the plus carbon and *vice versâ*.

The reversing of the current, however, was so troublesome and inconvenient that the use of the lamp was in many cases discontinued in consequence.

This idea, notwithstanding, is extremely ingenious, and it is very likely that before long some method will be devised by which this difficulty can be overcome.

At the same time, it is scarcely likely that in competition with the Brush system, the Jablochkoff candle would make much progress.

Motive Power.—Although the plant required for lighting by electricity would involve a much less outlay of capital, in the first instance, than that required for lighting the same area by gas, still, no doubt, a great deal of the subsequent economy of electric lighting, as compared with gas lighting, must depend upon the motive power applied in driving the dynamo machines to produce the electric current. This brings us to the immediate subject of our paper—namely, the advisability of applying water power for producing the electric potential. In a country like Ireland, where we have to import almost all our coal, and that at very great cost, it would never pay to adopt steam as the sole motive power, at least to such an extent as would be necessary if every town were lighted by electricity, because, with the demand the price of coal would increase, probably to such an extent as to preclude the possibility of its use. In France and Germany this difficulty as to steam power also arose, but with the result of producing highly economical machinery for utilising the water power of those countries. And here, it may be mentioned, that this fact is sometimes cited as a proof of the truth of the saying, "that every country bears upon its surface the power to direct the genius of her sons." And so England, with her enormous coal measures to work it, has produced, through the genius of James Watt, the magnificent steam engine; whilst France, with unlimited water power, but scanty coal supply, has brought forth the turbine—one of the most, if not *the* most, economical water-motors of the present day.

In Ireland, as was said before, where coal is scarce but water-power is plentiful, there would be nothing to prevent the utilisation of the latter for a great many industrial purposes, much less for the driving of dynamo-electric machines.

And when we recollect that the total water power of Ireland, according to the estimate of Sir Robert Kane, who went carefully into the subject, is equal to the enormous amount of one million and a quarter horse-power, we must surely censure ourselves for our want of enterprise in allowing this stupendous amount of energy to run uselessly to waste. The horse-power is here assumed to be equal to 12 cubic feet of water falling one foot per second—equal to 45,000lb. falling from a height of one foot in one minute, or about one-third more than the standard fixed by Watt, the one-third being intended to allow for friction.

The allowing of this immense power to expend itself uselessly cannot be said to be due to the fact that water-power is less economical than steam-power; quite the contrary, for water-power has been shown over and over

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again to be much less costly, either in first cost of machinery or afterwards to work with.

A great argument in favour of the economy of water-power is to be found in the fact that in England, where there was little need to economise coal, it being so very cheap, and the cost of steam power at a minimum, that, notwithstanding water-power has been largely utilised wherever it was at all possible to do so, one river, the Irwell, which passes Manchester and Bolton, having coal actually on each bank, is said to be probably the hardest worked stream in the world, it having, between Bacun and Prestolee, near Bolton, a total fall of 900 feet, 800 of which are actually utilised. In the year 1839 one-ninth of the total mill-power of Lancashire was water power; also, in the same year, according to the returns of the Factory inspectors, out of the total mill-power of England subject to inspection one-fourth was water power.

The late Mr. Robert Mallet, past president, some years ago having also gone carefully into this subject, in reporting to the Board of Works upon the rendering of the water supply of the River Dodder more uniform, stated that the cost of water power would be about one-tenth of the cost of steam power.

Sir Robert Kane also, in his "Industrial Resources of Ireland," speak- of water as compared with steam power, says:—"It is certainly much cheaper, not merely in Ireland, but in all places where it is available." And again he says:—"An eminent manufacturer in Leeds said to me that water power is cheaper than steam power at the pit's mouth." Mr. Fairbairn also, in reporting upon the great reservoirs which he, in conjunction with Mr. Bateman, constructed some years ago upon the River Bann near Killaloe, said that the cost of steam power was from £20 to £30 per horse power, whilst water power could be had for £3 per horse power per annum, or, as he says, an average of about one-eighth.

Mr. Bateman, however, goes farther than this, and says he believes, if there were properly constructed reservoirs to keep the supply constant, that water power would not be more than one-twentieth the cost of steam power.

Many other instances might be given to prove the economy of using water power, especially in Ireland. In a paper on dynamo-electric machines, read at the Institution of Civil Engineers in January, 1878, by Dr. Higgs and Mr. Brittle, Associates Inst. C.E., it is stated that the greatest economy in driving the dynamo machines was found to be with a turaine as the motive power. But, even if water power were not so extremely economical, as it undoubtedly is, there would be a great deal to be said in favour of utilising it to the utmost degree possible, leaving coal to be used in those places and for those purposes for which it is absolutely required. This would tend to reduce the cost of coal by lessening the demand, and the result would probably be that, in those exceptional districts where water was not available, steam power could then be had at a much less cost than at present. It would also have the effect of reducing the cost of goods in the manufacture of which coal is indispensable—not to speak of the benefits which the poor would derive directly from such a reduction in the cost of coal.

That water power will be made available in the future to a much greater extent than it has been in the past we may safely predict, for already there have been several instances of turbines being applied to the driving of dynamo-electric machines; notably that of the small town of Godalming, on the river Wey, where a very successful series of experiments has just been made with a view to the permanent lighting of the town by electricity, making use of the water power close at hand for the purpose. This town is an instance of, as has been pointed out in the beginning of this paper, a small town in which coal is very dear, it having to be brought from a great distance, but with plenty of water power close at hand.

Although the estimates given above, in the comparison of the relative costs of water and steam power, are based on the assumption that collecting reservoirs would be required to keep the head uniform, still there are a very large number of places in Ireland where no such collecting reservoir would be absolutely necessary, as, for instance, in the case of a deep and rapid stream of fairly uniform depth, the power might be calculated for the minimum head in dry seasons. This could easily be done by making the turbine adjustable, so that in the case of flood time, when the pressure was great, only one ring of the buckets might be opened, and when the water was at its minimum level the full power of the turbine could be utilised—thus making up in quantity what was lost in head, and *vice versâ*—and so keeping the speed of the turbine practically constant.

But perhaps the simplest way to apply water power to work turbines would be to take the power from a higher lock of a canal discharging at the lower level. This would give a practically constant head, and, of course, uniform speed, to the turbine. Many towns through which the canals run might thus be very economically lighted, to the advantage of the inhabitants as well as of the canal shareholders. And what is to prevent such an arrangement being successfully applied to a city like Dublin? where, with splendid canals on both north and south sides, low pressure turbines could easily be fixed to drive dynamo-electric machines—the wires conveying the current being carried into the city to supply the lamps. In such an event the author believes the saving effected would be enormous.

Again, the Vartry water might be made available for the driving of small high-pressure turbines, or water-pressure engines—the latter would, however, relatively require to be more powerful than the former, owing to their slower speed—so as to drive from a correspondingly large pulley in order to get up the high speed required for the dynamo-electric machines, which, to work at the high pressure of the Vartry, could be made so small as to cost very little indeed; for instance, a turbine with a wheel five inches in diameter could be fitted up for about £35, and would require, in order to develop about two horse-power, about 800 or 900 cubic feet of water per hour, whereas a water-pressure engine, to do the same work, would cost about £80 fixed, but the revolutions of the turbine would be 2,000 per minute while those of the water-pressure engine would be only 30 in the same time.

Of course the author is not prepared to say that the supply of Vartry water would be sufficiently great in quantity to meet such a demand upon it; but perhaps our President, than whom no person should know better, will give us some information on the point.

The principle, however, of conveying power to great distances in the form of water under high pressure is sound, it having been found to be a more economical way than any other—indeed, when the subject was discussed in the Institution of Mechanical Engineers, nearly all the members present were unanimous in its favour. In proof of this we have only to look at what has been done by Sir William Armstrong and others, where the water-power has been carried to a distance of several miles in some instances for the working of cranes and other machinery by hydraulic power. And here it may be mentioned, more as an historical fact than as absolutely bearing upon the subject, that many years before Sir W. Armstrong applied his method of accumulating and conveying power in practice the late Mr. Joseph Brahmah, the inventor of the hydraulic press, wrote to the late Mr. Robert Mallet, then a manufacturing and consulting engineer in Dublin, stating that he was prepared to apply his method of storing and conveying water-power to the working of cranes and other machinery on the quays of the river Liffey, just as has been done of late years by Sir W. Armstrong. Brahmah's letter will be found in the proceedings of the Institution of Mechanical Engineers.

But there is another motive power besides steam and water which has been very successfully adopted for generating electric potential—namely, coal gas, and which, probably owing to the vast improvements effected of late years in the engines driven by it, is becoming more popular every day. In many establishments where gas engines are used, such as printing offices and manufactories where small power is required, the cost of the power is very trifling, the engine only needing to be oiled and started in the morning and stopped in the evening, thus practically dispensing with an attendant, as any boy can start and stop it. There was one great fault found with gas engines when first they were introduced, which was the noise of the explosions of the gas at intervals. This objection has, however, been almost entirely overcome in the "Otto" engine.

This engine is extremely economical, using in the smaller sizes only about 24 cubic feet of gas per indicated horse power per hour, and in the larger sizes somewhat less.

The first cost of these engines is high; but, when we consider the fact that they require neither boiler nor chimney, such as would be absolutely necessary for a steam engine, there would still be a large margin of economy of capital in using them in many instances.

Gas engines are now made to work most successfully up to 24 indicated horse power, and with great economy; they have also been used for the driving of dynamo-electric machines in many places, notably in France, where it was found that, compared with steam power, the gas engine showed a saving of 3 to 1. It is by no means unlikely that attention will new, more than ever, be directed towards the improvement of these engines now that gas is likely to be available; and we may expect soon to see an increase in power as well as further economy effected in the using of them.

As to electricity itself as a motive power, so little is known practically as yet on the subject that the author may well be excused for not entering upon it.

Application of the Electric Light.—In fixing lamps for street lighting many have preferred to use very powerful lamps, each being applied to the lighting of a very large area. Others prefer to sub-divide the large space into very much smaller spaces, and use correspondingly smaller lamps.

To lay down any hard and fast rule would obviously be unwise, for, no doubt, for many wide and open spaces the first arrangement would, probably be preferable, whilst in bye-streets or smaller spaces less powerful lamps would be found to diffuse the light better; also bye-streets do not require such good light as the main thoroughfares.

One objection raised to very large lights was the dense shadow into which many bye-streets were thrown by them, but it is quite possible that if such lights were elevated to a height of 60ft. above the street, that by the time the rays reached the ground the atmosphere would have diffused the light so as to neutralise any great local shadow, and, probably, the lighting effect would be somewhat similar to strong moonlight.

Sackville-street might be lighted in this way with powerful lights, the Nelson column being used upon which to fix some of the lamps. This column, standing as it does at the intersection of four very important streets, might have a powerful lamp fixed, facing each of them; by this means the General Post Office entrance and both the tram stations would be well lighted, which would be an improvement upon the present arrangement, and thus a large portion of both Upper and Lower Sackville-street, not to speak of Henry-street and Earl-street, places where light is very much required at the turning into Sackville-street, would all be well lighted. Other lights could be fixed in Sackville-street, probably one at the Rotunda and one near O'Connell Bridge might be sufficient; but in all the important centres such as Dame-street, Westmoreland-street, &c., &c., there should be plenty of light such as powerful electric lights could supply. It would be beside the question to do more than indicate in a general way what ought to be done, and many other equally good positions might be mentioned which equally deserve to be well lighted. Indeed, a stranger visiting Dublin for the first time might very well imagine that we were ashamed of our Irish architecture, as much as possible, apparently, being done to keep our public buildings in almost total darkness. There is no doubt, also, that it would be a protection to the public to light the streets properly, and fewer robberies and instances of garotting would probably be heard of if this were done.

(TO BE CONTINUED.)

TRANSFERRING CABLE IN HARBOUR.

Translated *resumé* of a petition presented by the Eastern Telegraph Company's Madrid agent to the Spanish Minister of Finance, *re* transfer of cable from one ship to another:—

"As representative of the Eastern Telegraph Company, I beg most respectfully to place the following before your Excellency. Amongst others, the Vigo-Portheurnow, Vigo-Lisbon, and Vigo-Caminha cables are the property of the above company. Unfortunately, on account of accidents at sea, and of other unforeseen causes, these cables have broken at various times, and for this reason, to the exclusion of all other objects, the company possesses several steamers fitted up for the repairs of cables and the restoration of communication.

"These vessels being used for no mercantile operation whatever, are treated everywhere in an exceptional manner, excepting in the port of Vigo.

"A recent case will give your Excellency an idea of the inconvenience which the rigorous application of regulations may cause not only to the Company, but also to the general public service.

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"On account of the severe gales in October the three cables (Lisbon-Porthcurnow, Vigo-Lisbon, and Vigo-Caminha) were broken. The steamers—'John Pender' and 'Retriever'—were ordered to Vigo Bay, to wait for fine weather, and then to immediately commence the necessary repairs. The former steamer from London, the latter from the South. The 'John Pender,' coming from London, had on board more than sufficient cable for these repairs, but the "Retriever" had expended hers in other operations. For which reason the consignee in Vigo requested permission of the Administrator of Customs to allow a transfer of cable from one ship to the other, to take place in that port. This permission was most definitely refused, the Administrator giving as his reason the fact of the 'Retriever' having arrived without bringing a manifest signed by the Spanish Consul at her last port.

"The extreme urgency of the operations of cable repairs makes it impossible for cable ships to comply in all cases with this rule, and in this case the ships were compelled to leave the port and effect the transfer at sea, which operation cost four times the number of hours in which it could have been performed at anchor in the port of Vigo, as well as exposing the ships to many risks.

"Telegraphic communication being so essential to the commercial life of nations, any delay in its re-establishment caused by inconvenient rules is sensibly felt, and might cause an interruption to last a long time, through the ships not being able to take advantage of a few hours' fine weather, causing much loss to the public and absolutely no gain to the Customs department.

"The Spanish Telegraph Department, always anxious to obtain rapid and perfect communications, will, if you deem it necessary, be able to inform you as to the grave losses which may be caused by a rigorous application of Customs rules in such cases.

"After the above explanation I now beg that you will cause to be issued to the various Custom Houses, or at least to the one in Vigo, a just and equitable order, that no difficulties be placed in the way of such operations, but, on the contrary, that all facilities be offered, as is done in all other ports of the world. If necessary, an *employé* of the department can be present to witness the operation, so that he may see and report that nothing else takes place," &c.

THE ORIENTAL TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of the members of the above Company was held at the City Terminus Hotel, Cannon-street, on the 28th inst. "for the purpose of considering and, if thought desirable, of passing a resolution approving and confirming a certain conditional agreement made, or intended to be made, between Alexander Graham Bell of the first part, Thomas Alva Edison of the second part, the Oriental Bell Telephone Company of New York of the third part, the Anglo-Indian Telephone Company (Limited) of the fourth part, George Edward Gouraud, Gardiner Green Hubbard, John Parks Bigelow, William Walter Cargill, and James Merrill Ormes of the fifth part, and this Company of the sixth part, whereby it is proposed to effect various modifications or alterations in the subsisting agreements for the purchase by the Company of the properties and rights described in the agreement of the 25th of January, 1881, referred to in the memorandum and articles of association of this Company, and the said other agreements, or some or one of them particularly, by reducing the amount of the consideration to be paid by this Company for such purchase." The chair was occupied by John Pender, Esq., M.P., chairman of the Company.

The SECRETARY (Mr. W. G. Hall), having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen—You have heard the notice read, and the object of the meeting is to ask you to sanction a resolution. That resolution has sprung out of the settlement of our arrangement with the vendors of the various patent rights, privileges, and goodwill to this Company. There are several parties connected with that sale, and where there are so many people connected with a thing there are very often some omissions in regard to details. It so happened that this was pretty much the case in the bargain we made with the vendors; but I am happy to say that in coming to close our agreement with them, and to settle the question, we found that we had some advantages on our side, which we thought it was only right we should avail ourselves of. We have done so, and I am very glad to say that the vendors have met us in a very proper spirit. Such disputes are usually settled either by law or by arbitration, but in this case we settled the business without reference to either the one or the other. The result has been that we secure some £10,000 in money and £25,000 in shares. You must not suppose that we look upon this in any other light than that of a very considerable addition to our capital. We believe that we, the Oriental Telephone Company, bought privileges at all events as good if not superior to any of the existing telephone companies. We have secured, perhaps, the best field for telephonic enterprise in the world. We have India, with its teeming population; Australia, with its English-speaking population, which is making such rapid progress, and where, we have no doubt, advantage will be taken of the telephone very much in the same way as in America; and we have our other possessions, all likely to use this new mode of communication. When I compare our Company, with its modest capital and its enormous area, possessing all the best telephonic patents—such as the Bell, Gower-Bell, and Edison — I find that we have probably the most valuable telephone enterprise that exists at the present moment. Our capital, as you are aware, is nominally £300,000, but we shall really be working with something like £115,000. We have received to-day a telegram from Calcutta to the effect that at Bombay, Madras, and Calcutta exchanges will be opened from the 15th to the 20th of next month, and when they are opened I think we may begin to look at our undertaking as a dividend-paying concern. You are aware that we have not yet been twelve months in existence, and that all these works had to be constructed. We entered on a field which was barren of everything in the way of telephonic instruments, except the few which had been sent out merely to be on the ground at the time we took possession. The whole thing had to be constructed. We had to make our arrangements with the Indian Government, and fortunately we have made such arrangements as will give considerable encouragement to private enterprise there; and now, from the accounts we have received, everything seems to be of the most encouraging nature. In Egypt we have our telephone at Alexandria, and our system there is opened with something like 60 subscribers, a number likely to be doubled in a very short space of time. Comparing the Oriental Telephone Company with those in England—our nominal capital, as I have said, is £300,000—there are the United Company, with its capital of £400,000, which I believe to-day is worth about £1,000,000 in the market; the National Company, £600,000; the Lancashire and Cheshire Company, £250,000; the Consolidated Construction, £300,000; the British and Irish Telephone, £100,000; and the European, £500,000. We have an area more extended than any of the companies—in fact, we have an area more extended than all put together; and with our limited capital, with even a moderate return from each of the different places we are now acting on—Calcutta, Bombay, and Madras, and I hope, before long, in the Straits Settlements, Java, Hong Kong, and China, I think we shall show a very satisfactory state of things before the coming year ends. I would ask you to bear in mind this fact, that by this amended agreement we are richer by £35,000, and I think our property has very much increased in value since I had the pleasure of addressing you four months ago. I should mention that one of our stations, is Honolulu, where we have 175 subscribers, with the prospect of an increase to 200. That is a remarkable evidence of the progress of these islands. The solicitor will now read the resolution, and if necessary, and you desire it, he will also read the amended deed which we wish you to approve of to-day.

The SOLICITOR (Mr. Renshaw) having read the resolution,

The CHAIRMAN said: Would you like to have any points of the agreement read to you. This resolution very much embodies the whole spirit of it, but if anyone desires it the whole agreement can be read. After a pause, he added: Then I suppose you will take the resolution as sufficient and I move it.

Sir JULIUS VOGEL having seconded the motion,

The CHAIRMAN submitted it to the meeting, and declared it carried unanimously. Continuing, he said: That is the whole of the business, and I may say that I rather feel disposed to congratulate you on the amended agreement. I think we have obtained a considerable amount in our exchequer, and looking to the progress of telephonic property since we made this purchase I think we have a very valuable property indeed in hand, and if I were to make such a suggestion as that our undertaking should be sold to-day I think we should find a good many competitors for our property. I think it is a very valuable property in the market, looking at the competition now going on in telephones, and at the price at which some of these enterprises stand in the market.

In reply to a vote of thanks,

The CHAIRMAN said: I am very much obliged to you for your vote of thanks, and for the confidence you have shown in your board of directors. I should just like to make one or two further remarks. As you are all probably very well aware, I am very intimately connected with the submarine telegraph system of the world. We had, going back twelve years ago, great trouble and labour to establish that system, but in that period we have put something like £25,000,000 into the sea, and at the present moment we may say that there is not a centre of commerce or civilisation in the world which is not connected by submarine telegraphy. My hands were quite full when I took up this question of the telephone enterprise, but I felt that it was a hand to telegraphy, and that it was necessary to combine as far as possible the electric element in the working out of the two systems. Before long I anticipate that the telephone system will be going hand in hand with the telegraph system throughout the world, and it is for that reason that I occupy the chair of this Telephone Company, and with the great desire to see this enterprise progress. I believe that there is great progress in it, and as between the telegraph and the telephone I tell you that there is an enormous future for the telephone. I beg to thank you for your attendance to-day, and to wish you all a happy New Year [applause].

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES DEC. 28.		BUSINESS DONE WEEK ENDING DEC. 28. Highest.		Lowest.	
Anglo-American	51,	51¼	.....	51¼	.....	51¼
Do. Preferred	79,	80	.....	80	.....	79¼
Do. Deferred	21¾,	22¼	.....	22¼	.....	22
Brazil Submarine	11¼,	11¾	.....	11¾	.....	11¼
Cuba	9½,	10	.....	—	.....	—
Do. Preference	16,	17	.....	—	.....	—
Direct Spanish	5,	5½	.....	—	.....	—
Do. Preference	14½,	15½	.....	—	.....	—
Direct United States Cable	10¾,	10¾	.....	10¾	.....	10¾
Eastern Telegraph	10½,	10¾	.....	10½	.....	10½
Do. 6 per Cent. Preference	12¾,	12¾	.....	12¾	.....	12¾
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	11,	11¼	.....	—	.....	—
German Union	10,	10½	.....	—	.....	—
Globe Telegraph and Trust Company	6¾,	6¾	.....	6¾	.....	6 7-16
Do. Preference	12¼,	12¾	.....	12¾	.....	12¼
Great Northern	12,	12½	.....	12½	.....	12
Indo-European	27½,	28½	.....	—	.....	—
Mediterranean Extension	2¼,	2¾	.....	—	.....	—
Do. Preference	9½,	10	.....	—	.....	—
Reuter's	12,	12½	.....	12½	.....	12¼
Submarine	290,	300	.....	—	.....	—
West India and Panama	1¾,	2¼	.....	—	.....	—
Do. 1st Preference	7⅞,	8¼	.....	8	.....	7 15-16
Western Brazilian	7⅞,	7¾	.....	7 11-16	.....	7 11-16
West. Union 7 per Cent. 1st Mortgage	123,	128	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	104,	107	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1½	.....	1½	.....	1 7-16
Oriental	¼,	½	.....	9-16	.....	9-16
United Telephone	12⅛,	12½	.....	—	.....	—

ELECTRIC LIGHT.

Electric Light and Power	1¼,	1½	.....	1 5-16	.....	1 3-16
Anglo-American Brush	8¾,	9¼	.....	9¼	.....	8¾

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

1027. IMPROVEMENTS IN ELECTRIC LAMPS, &c., *J. A. Berly.*—10*th March*, 1881.—(*Not proceeded with.*) 4*d.*

This invention refers to lamps in which the regulating mechanism is dispensed with, and the carbons are placed parallel to each other and fixed in separate holders, one being fixed and the other made to approach or recede from this one to produce the arc. The invention consists in the substitution of a strip of flexible material such as metal for the hinge pivot or oscillating contrivance for approaching the one carbon to the other, the movable carbon is also attached to an armature. The invention also relates to an automatic method of lighting a fresh pair of carbons, when the first pair are consumed.

1412. CARBONS FOR INCANDESCENT ELECTRIC LAMPS, *J. Scott and W. H. Akester.*—31*st March*, 1881. 2*d.*

The inventors employ the fibre used by brush makers called kitool, and also coir or bass, surrounding it with sand or charcoal during carbonisation, which is separated afterwards.

1550. IMPROVEMENTS IN MEANS FOR PROTECTING MAGNECTIC NEEDLES FROM LOCAL ATTRACTION, *J. S. Gisborne.*—9*th April*, 1881. 6*d.*

The inventor surrounds the needle with several series of concentric segments, or other shaped pieces of iron, which also extend underneath the needle and meet in the centre. These pieces of iron are insulated from each other by ebonite or other material, or the inventor surrounds the needle by a coil of silk-covered wire, through which a constant or intermittent current is passing. The needle is thus preserved from local attraction, and the current, in the latter case, controls the polarity of the coil.

1679. IMPROVEMENTS IN TELEPHONIC AND TELEGRAPHIC EXCHANGE SYSTEMS, &c., *Dr. J. N. Cutbertson and J. W. Brown.*—16*th April*, 1881. 6*d.*

To work a central exchange system on a complete metallic circuit, the inventors employ ordinary switch boards with a number of insulated parallel bars, to which conducting wires leading to distant stations are attached. At right angles to these wires are a number of other insulated bars, to which any one or other of the first-mentioned bars can be coupled by insertion of a metallic peg at the point where the bars cross one another. One of the cross bars of each switch board is ordinarily connected to earth. All the return wires from distant stations are connected to this bar, and where a number of similar switch boards are used, all these bars of the several switch boards are coupled together by a conducting wire. Thus the return circuit from all the distant stations will be conveyed through this wire, and the coupling of the wire from one station to the wire leading to another will be effected by shifting a single peg only, that is, one peg for each station. In central exchange systems where complete metallic circuits are not used, the inventors propose to have a return wire from each station, and to use a central system of earths, which are more under supervision, and can easily be made good. The invention also refers to a method of insulating the wires with asbestos and glycerine or similar substances, and also to a particular method of suspending said wires to keep them apart. The specification is accompanied by drawings.

1751. ACTINOMETERS OR INSTRUMENTS FOR MEASURING LIGHT, *F. Hurter.*—23*rd April*, 1881. 6*d.*

This consists in measuring the intensity of light by causing rays of different refrangibility to be received by or pass through different colours, and to be absorbed by two sensitive parts of a differential thermometer, and measuring the difference of temperature thus produced, whence the intensity of the light may be ascertained.

1770. IMPROVEMENTS IN RECEIVING AND TRANSMITTING APPARATUS OF PRINTING TELEGRAPHS, *W. J. Burnside*, 23*rd April*, 1881.—(*Not procceded with.*) 2*d.*

This invention relates to automatic printing telegraphs, and its object is to increase the rapidity of operation of the receiver and to provide improved means of maintaining the synchronism between the transmitting cylinder and the type wheel of the receiver. It is an improvement on the patent granted to H. von Hoevenbergh, on the 10th December, 1880, No. 5162.

1943. IMPROVEMENTS IN SYSTEMS OF ELECTRIC LIGHTING, *E. G. Brewer*, 4*th May*, 1881.—(*A communication from T. A. Edison.*) *Price* 6*d.*

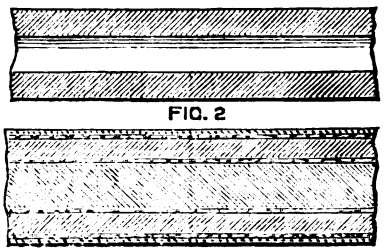
This relates merely to an arrangement of circuit and lamps, whereby lamps of different candle power may be used. The resistances and surface areas of carbons are regulated by a nominal standard.

2175. REGENERATING OR RESTORING THE ENERGY OF ELECTRIC BATTERIES.—*W. R. Lake* 18*th May*, 1881. (*A communication from L. Marche*). *Price* 4*d.*

The reconstitution is effected by passing through the battery an electric current in the direction opposite to its own current.

2437 METALLIC CIRCUITS FOR ELECTRICAL TRANSMISSION, *G. E. Edmonds, London.*—2*nd June*, 1881.—(*A communication from G. M. Mowbray.*) 6*d.*

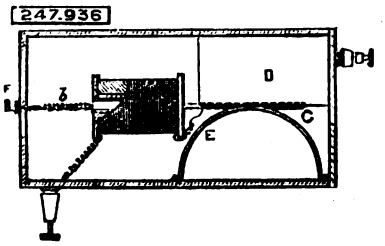
This is an arrangement for a return wire. Fig. 1 shows longitudinal and cross section of outward



conductor, with groove for insulated conductor; Fig. 2 shows arrangement for multiple conductors.

247,936. REGULATOR FOR ELECTROPHORES OR SECONDARY BATTERIES, *James A. Maloney and Franz Bürger, Washington, D.C., assignors, by direct and mesne assignments, to the American Electrophore Company, same place.*—*Filed July* 23*rd*, 1881.

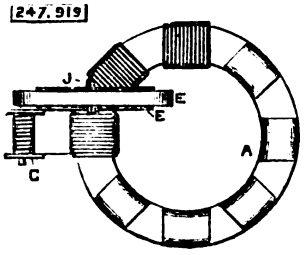
Claim.—In combination with the electrophore, the electro-magnet B, wire rod C, resistance-



block D, spring E, set screw F, spring B, and binding posts, substantially as described, and for the purpose set forth.

247,919. DEVICE FOR WINDING THE ARMATURES OF ELECTRIC MACHINES, *Robert A. Johnston and William H. Bulcroft, Cleveland, Ohio.*—*Filed May* 2*nd*, 1881.

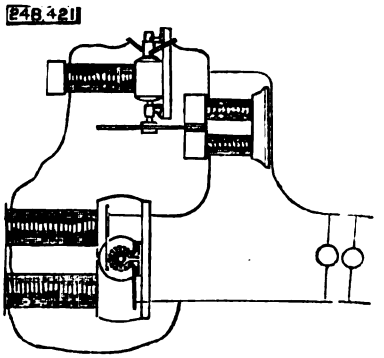
Brief.—A guide is clamped to the annular core, and supports a ring which carries the ring of wire. The ring is made in sections, which are secured



together by lugs and bolts to enable it to be passed through the annular core. *Claim.*—(1) The combination of the stationary wheel F and outer wheel E, carrying the spool G, as and for the purposes set forth and described. (2) A device for winding armatures of electric machines, consisting of a divided wheel, E, turning upon a stationary wheel or guide, F, attached to an annular armature, as and for the purposes set forth and described. (3) The combination of the sectional wheel E having a screw, X, spring, Y, attached thereto, and bobbin or wire-holder, G, with the inner stationary wheel, F, as and for the purpose set forth. (4) The inner guide-wheel F, having thumb-screws and lugs, J, to adjust and hold it upon the armature A, as set forth and described.

248,421. CURRENT REGULATOR FOR DYNAMO-ELECTRIC MACHINES, *Thomas A. Edison, Menlo Park, N.J., assignor to the Edison Electric Light Company, New York, N.Y.*—*Filed March* 5*th*, 1881.

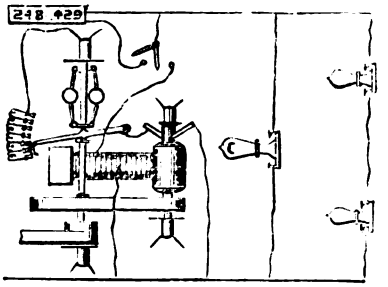
Brief.—The invention is clearly explained by the drawing and claims. *Claim.*—(1) The method of controlling or regulating the regenerative force of a dynamo or magneto-electric machine consisting in throwing into the field magnet circuit a variable and controllable counter electromotive force, substantially as set forth. (2) The combination, with a generator, of an electromotor included in the field-magnet circuit by its counter electromotive force, substantially as set forth. (3) The combination of a generator, an electro-



motor included in the field-magnet circuit, and a magnet in the supply or consumption circuit controlling the rate of rotation of the motor, substantially as set forth. (4) The combination, with a motor, of a disc driven thereby, and a magnet, between whose poles or in whose field the disc rotates to vary and control the rate of rotation of the motor, substantially as set forth. (5) The combination of a generator, an electromotor in the field-magnet circuit, carrying a disc upon its rotating shaft, and a magnet in the supply circuit in whose field the disc rotates, whereby the rate of the motor and the strength of the field circuit are varied and controlled, substantially as set forth.

248,429. ELECTRIC MOTOR, *Thomas A. Edison, Menlo Park, N.J., assignor to the Edison Electric Light Company, New York, N.Y.*—*Filed March* 3*rd*, 1881.

Brief.—The device is intended to prevent the disturbance of electric lights when a motor is thrown into the same circuit; and to this end it consists of a variable resistance included in the motor-circuit normally or when at rest, and a governor driven by the motor, and means controlled by the governor for cutting out the resistance gradually as the speed of the motor increases



and its counter electric current is sent to line. The resistance cut out should be the equivalent of the counter current at any given speed. *Claim.*—The combination, with an electro-motor, of a resistance included in its circuit normally or in a state of rest, and means operated by the motor and arranged to gradually cut out the resistance as the motor speeds up, and to entirely cut it out when the motor reaches a desired predetermined speed, substantially as set forth

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ADDRESSES.

M. THEILER & SONS, Manufacturing Electricians,
6, CANONBURY ROAD, LONDON, N. Factory: 1, Alwyne-lane, N.
pecialities—Morse Instruments, Type Printers, Cable Relays and Keys, DUPLEX, Quadruplex, & Translating Apparatus, P.O. Pattern.
THEILER'S PATE T TELEPHONE TRANSMITTER, with Sensitive Bell, &c. Complete, price £3 10s.

TAYLOR and Co., Mica Merchants, 90, HATTON GARDEN, LONDON.

W. T. GLOVER and Co., Insulated Wire Manu-facturers, 25, BOOTH-STREET, MANCHESTER. Works: 4 and 5, BRIDGEWATER-STREET, BROUGHTON-ROAD, SALFORD.
Specialities—Specially covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron Wire for Aerial Lines. Fancy covered Copper Wire (Paraffined) for Telephonic and Bell purposes. Cotton covered G.P. Wire for Bell Work. Special Makes of Electric Light Leads for the Brush, Gramme, &c., systems.
All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

RANSOMES, HEAD, & JEFFERIES, Orwell Works,
IPSWICH. London Office: No. 9, GRACECHURCH-STREET, E.C.
Specialities—Portable, Vertical, and Stationary Engines, fitted with patent governors, as used in the electric lighting on the Thames Embankment, London, &c.

BRITISH ELECTRIC LIGHT COMPANY (Limited),
HEDDON-STREET, REGENT-STREET, LONDON, W.
Gold Medal at the Paris Electrical Exhibition, 1881.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

EDWARD PATERSON, Electrical and Telegraph Engineer, 76, LITTLE BRITAIN, LONDON, E.C., and European Telegraph Works, POWNALL-ROAD, DALSTON.
Telephones and Transmitters, and all Fittings for Central Exchange Systems and Private Lines. Ayrton and Perry's Instruments for Electric Light Measurements. Electric Lighting Apparatus, Cables, &c. House and Mine Signals.

PHILLIPS BROS., Electricians and Electrical Wire Manufacturers, MACINTOSH-LANE, HOMERTON, LONDON.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

JULIUS SAX, 108, GREAT RUSSELL STREET, BLOOMSBURY, LONDON. Works: MORWELL STREET, BEDFORD SQUARE.
Electric Bells, Fire and Thief Alarms, Water Gauges, Watchmen's Clocks, Telephones and Transmitters. Lines Erected and Maintained. Lightning Conductors. Electric Light Apparatus supplied and fixed. Prize Medal London, 1862; First Prize, Sydney, 1879; Prize Medal, Melbourne 1880; Prize Medal, Paris, 1881.

BARRAUD and LUNDS, 41, Cornhill, London, E.C.
Inventors, Patentees, and Manufacturers of Synchronised Clocks, Time Balls, Flashing Signals, and all the Apparatus connected with the Determination, Distribution, and Control of Time Signals.

NEWTON'S PATENT LAW and PRACTICE, Price 2s. 6d.
This standard work contains all legal and other information necessary for intending patentees, including Government charges, agency fees, and rules of the Commissioners of Patents.
TRUBNER and Co., Ludgate-hill, and may be obtained at the Office for Patents, 66, Chancery-lane, W.C.

J. A. BERLY'S ELECTRICAL DIRECTORY and ADVERTISER of ENGLAND, 1882.
INTENDING ADVERTISERS in the 1882 EDITION (first issue), should at once apply for particulars, terms, &c., to J. A. BERLY, 16, New Bridge-street, London, E.C.
For Press opinions vide "Times," 18th; "Iron," 18th; "Engineering," 18th; "Electrician," 19th Nov., 1881; "Telegraphic Journal," 1st Dec., 1881, &c.

WINCHESTER.—The Lighting Committee of the Town Council are prepared to receive SUGGESTIONS for LIGHTING the STREETS of the CITY by means of ELECTRICITY. Particulars to be sent to me on or before the 14th of JANUARY NEXT. The Committee do not pledge themselves to adopt any system or be liable for any expenses to be incurred.
By order, WALTER BAILEY, Town Clerk.
Guildhall, Winchester, Dec. 19, 1881.

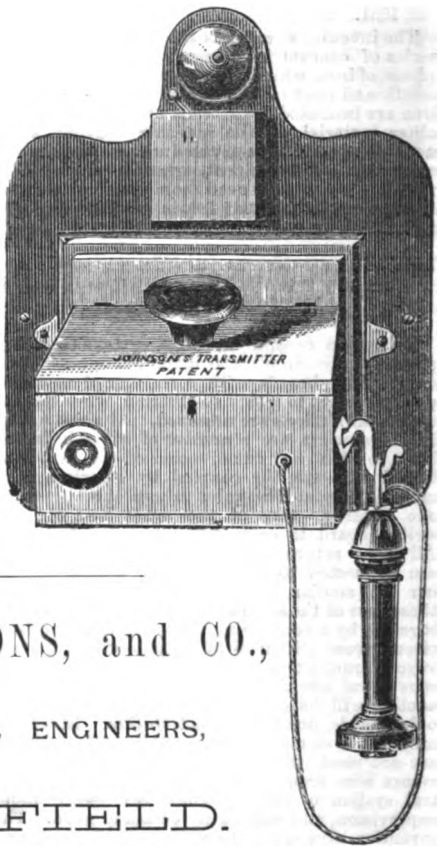
TO CONTRACTORS and Others.—The Cape Town Municipality invite TENDERS from persons willing to CONTRACT for the LIGHTING of CAPE TOWN by GAS, LIME, ELECTRIC LIGHT or other illuminating power. Plans of Cape Town, and every other necessary information, can be ascertained on application to the SOUTH AFRICAN LOAN, MORTGAGE, and MERCANTILE AGENCY (Limited), 9, King William-street, E.C., the London Agents of the Cape Town Municipality.

WANTED, MANUFACTURING ELECTRICIAN for the workshop. Permanent and improving berth to a competent man. Address, stating age, experience, and salary required, to "Electric," care of Willing's Newspaper Advertisement Offices, 353, Strand, W.C.

WILLING'S ELECTRIC SIGNS.—Suitable for Signs, Facias, Window Decorations, Novelties, Advertisements, &c., &c. Cheap and very effective.
The Proprietor is prepared to APPOINT a LIMITED NUMBER of PROVINCIAL AGENTS.
King's Cross, London, W.C.

Just published, Crown 8vo., cloth, 12s. 6d.
A HANDBOOK of ELECTRICAL TESTING. By H. R. KEMPE, Member of the Society of Telegraph Engineers, Assoc. Mem. Inst. C.E. Second Edition, Revised and Enlarged.
London: E. and F. N. SPON, 16, Charing Cross. New York: 446, Broome-street.

JOHNSON'S
PATENT
TRANSMITTER.



BELL'S PATENT
TELEPHONE.

The best combination for Exchange and Private Lines.

TASKER, SONS, and CO.,
ELECTRICAL ENGINEERS,
SHEFFIELD.

VULCANITE.
HARBURG INDIA-RUBBER COMB COMPANY.
LONDON WAREHOUSE: F. WINTER.
138, LONDON WALL, WOOD ST., E.C.
EBONITE.

HARBOROW & CO.,
ELECTRIC LIGHT ENGINEERS
AND
TELEGRAPH INSTRUMENT MANUFACTURERS,
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CRYSTAL PALACE.

INTERNATIONAL ELECTRIC EXHIBITION.

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3. MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.
4. CABLES, WIRES, LIGHTNING CONDUCTORS.
5. APPARATUS FOR MEASURING ELECTRICITY.
6. TELEGRAPHS AND SIGNALS.
7. TELEPHONES, MICROPHONES, PHOTOPHONES.
8. ELECTRIC LIGHTING.
9. ELECTRIC MOTOR POWER.
10. ELECTRO-MEDICAL.
11. ELECTRO-CHEMISTRY.
12. MAGNETS, COMPASSES, HOROLOGY, etc.
13. MISCELLANEOUS.
14. GENERATORS, GAS, STEAM, WATER ENGINES, etc., APPLICABLE TO ELECTRIC INDUSTRIES.

SPACE HAS ALREADY BEEN ALLOTTED TO THE FOLLOWING EXHIBITORS:—

CLASS VIII.—ELECTRIC LIGHTING.

Anglo-American Brush Light Corporation.
British Electric Light Company.
Cance, A.
Clark (Latimer), Muirhead and Co.
Compagnie Générale d'Electricité.
Crompton, R. E.
Edison, T. A.
Electric Light and Power Generator Company.
Electric Light Engineering Company.
Electric Lighting Supply Company.
Electric Light Carbon Company.
Elmore W.
Gerard, A.
Graham, D. H.
Gravier and Co.
Hammond and Co.
Hawkes (G.) and Co.
Henley, W. T.
Macdonald, J. Hay Athole.
Mignon et Rouart.
Rowatt and Fyfe.
Scientific Toy Company.
Siemens Brothers and Co.
Siemens Frères.
Somzée, M. Leon.
Swan Electric Light Company (Limited).
Strode and Co.
Thomas, Evan.
Varley (S. A.) and Co.
Werdermann, R.
White House Mills Company.

Announcements of other allotments will be made from time to time.

THE ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

IN CONNECTION WITH THE EXTENSIVE SYSTEMS OF

The WESTERN UNION TELEGRAPH COMPANY of AMERICA, and The MONTREAL TELEGRAPH COMPANY of CANADA.

FOUR DIRECT CABLE ROUTES

Between EUROPE and AMERICA, via Valentia, Ireland, and via Brest, France.

Telegrams accepted at any Postal Telegraph Station in the United Kingdom, or at the Company's Offices,

No. 23, THROGMORTON STREET, LONDON, E.C.
No. A1, THE EXCHANGE, LIVERPOOL.

At which Senders, in order to save time, should hand their Messages DIRECT to the Company.

REDUCTION OF TARIFF.

On and after 1st August, 1881, the rate for the transmission of Telegrams from the United Kingdom to NEW YORK and CANADA will be

1/- per word.

The name of the place from which Messages originate will be transmitted free of charge.

Rates to other places and further particulars may be obtained at the following Offices and Agencies of the Company:—

LONDON	No. 23, THROGMORTON STREET.
LIVERPOOL	No. A1, THE EXCHANGE.
MANCHESTER	No. 20, BROWN STREET.
GLASGOW	No. 59, ST. VINCENT STREET.
PARIS	No. 28, RUE CAUMARTIN.

T. H. WELLS, *Secretary.*

General Offices of the Company, 26, Old Broad Street, London, E.C.

NEWALL'S PATENT LIGHTNING CONDUCTORS.

Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

NEWALL & CO.'S PATENT COPPER-ROPE LIGHTNING CONDUCTOR,

As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public. It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

SOLE PATENTEES OF UNTWISTED WIRE ROPE.

Manufacturers of Iron and Steel Ropes for Colliery and Railway purposes. Rigging Ropes, Guide Ropes, &c.

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THE SCHOOL OF SUBMARINE TELEGRAPHY, TELEPHONY, AND ELECTRIC LIGHT.

ESTABLISHED IN 1868.

4, GEORGE STREET, HANOVER SQUARE, LONDON, W.

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of the various systems of working in general use, the following subjects:—

MATHEMATICS, MECHANICS, and CHEMISTRY, } In relation to Telegraphy.

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ELECTRO-STATICS.

ELECTRO-DYNAMICS.

MAGNETISM.

METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction.

TESTING FOR and LOCALISING FAULTS, &c., &c., &c.

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A complete practical and theoretical course of instruction on the TELEPHONE and the ELECTRIC LIGHT, and their commercial utilisation, has now been added to, and embodied in, the ordinary curriculum, as the advantage of being associated with any great commercial application of science at an early period of its development is one which has been so often exemplified that it can scarcely fail to be appreciated by those who have in view professional success.

That TELEPHONIC communication and ELECTRIC LIGHTING constitute such applications is sufficiently shown by their rapidly increasing progress; and therefore no pains or expense have been spared to place at the disposal of the pupils the technical and scientific instruction requisite to qualify candidates for the most important posts in connection with these new branches of electrical engineering. In order that the instruction in the erection, adjustment, testing, and working of TELEPHONE and ELECTRIC LIGHT circuits may also be thoroughly practical, complete working telephone exchanges upon the various systems in use in different countries have been fitted up; every kind of telephone, for both exchange systems and private lines, with all apparatus used therewith, is provided (in duplicate when possible, so that students may be able to dissect and reconstruct the same). The necessary tools and materials are available, and every facility is given for conducting experiments by the pupils desirous of so doing, and a similar course is being pursued with the VARIOUS LAMPS and MACHINES, &c., in the ELECTRIC LIGHT Department, so that pupils from the School are in a position to enter either of these new fields.

The complete Practical and Theoretical course extends over a period of Six Months.

Arrangements have been made so that Inventors, Amateurs, and others can now have every facility, with all necessary apparatus provided in private rooms, to compare, test, or perfect any Inventions, Apparatus, &c., connected with Telegraphy, Telephony, and the Electric Light. Financial and the highest professional assistance can also be had.

Further particulars may be obtained on application to

W. N. TIDDY, *Secretary.*

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS,

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

ELECTRIC LIGHT.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

Capital £800,000; First Issue £400,000.

VICTORIA WORKS, BELVEDERE ROAD, & VINE STREET, LAMBETH.

The Corporation is prepared to give estimates and to book orders for the SUPPLY of MACHINERY and LAMPS, upon the Brush System, for lighting up Factories, Warehouses, Railway Stations, Docks, Streets, &c.

The Corporation are willing to receive applications for licences or concessions for defined districts, counties, or towns in the United Kingdom.

By the Brush system any number of lights, from 1 to 40, each of 2,000 candle power, or any number from 1 to 12, each of 6,000 candle power, or a single light of 50,000 or more candle power, can be produced from one dynamo machine. The connecting wires may be extended over circuits of many miles, and it is claimed that economy, constancy, and simplicity are secured at a less cost than by any other system.

The Corporation is also prepared to supply for domestic lighting, incandescent lamps of 10-candle power and upwards, manufactured with the newest improvements, under the "Lane-Fox" system. These lights are suitable for private houses, business offices, clubs, hotels, &c.

Concessions for the colonies and for foreign countries of the valuable patent rights under both of these systems, including methods of manufacture, regulation, and distribution, can be negotiated with the Corporation.

All inquiries to be addressed to the Secretary, at the offices, Belvedere-road, Lambeth, S.E.

ESTABLISHED 1861.

BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings Chancery-lane

CRYSTAL PALACE.—A Lady has THREE VACANCIES in her well-appointed house for GENTLEMEN who may require a home during the Electric Exhibition.—Address, Mrs. H., Ellison House, Cintra Park, Upper Norwood.

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SLIP

ELECTRIC LIGHT AT VICTORIA (BRITISH COLUMBIA).—The Brush Company are erecting some of their lights in the above town.

ELECTRIC LIGHT AT GRIMSBY.—It is stated that the Brush light is to be introduced into Grimsby Docks by Messrs. Hammond and Co.

ELECTRIC LIGHTING FOR ONTARIO.—News from Canada says that a fresh proposition for lighting the town of Ontario by electricity has been set on foot.

ELECTRIC LIGHTING FOR MINES.—A premium of £500 has been offered by Mr. Ellis Lever, of Manchester, for the best system of electric lighting for mines.

CABLE REPAIRED.—The Eastern Telegraph Company notify the repair of the Hong Kong-Amoy cable, thus restoring telegraphic communication with Amoy.

THE CROMPTON LIGHT AT ROTHERAM.—The Rotherwood Iron and Steel Company's works at Rotherham are now lighted by Messrs. R. E. Crompton and Co's arc lights.

ELECTRIC LIGHT AT VIENNA.—On Tuesday night the Brush system of electric lighting was tried in the streets adjoining St. Stephen's, Vienna. The trial is to last one month.

THEATRES AND FIRES IN BRUSSELS.—The police authorities at Brussels have determined to have telegraphic communication between the theatres, the barracks, and fire stations.

THE AMOY CABLE REPAIRED.—The Eastern Telegraph Company (Limited) notifies the repair of the Amoy-Shanghai cable, thus restoring telegraphic communication with China and Japan.

WESTERN AUSTRALIA.—According to the financial returns of this colony for the quarter ending 30th September last there had been a falling off in the revenue from telegrams amounting to £721.

THE TELEPHONE IN PARIS.—A telephone line between Paris and Versailles is to be erected. If this is successful another will be set up between Paris and Rouen, and towns still further distant.

ELECTRIC LIGHTING IN TURIN.—The Royal Theatre at Turin is to be lit by the electric light in place of gas. Electric lights are also to be used as an experiment in the Town Council meeting room.

THE TELEPHONE IN ADELAIDE (SOUTH AUSTRALIA.)—News from Australia, dated the 18th November, says that telephonic communication will be completed between Adelaide and Port Adelaide shortly.

THE TELEPHONE IN ZURICH.—The number of subscribers to the Zurich Telephone Exchange now exceeds four hundred. The telephone company have undertaken to wake their subscribers at any hour in the night.

THE BERLIN ELECTRIC RAILWAY.—It is said that Messrs. Siemens are carrying out experiments at Berlin to ascertain the effect of winter weather, snowstorms, frost, &c., on the conducting wires, &c., of their electric railway.

CABLE REPAIRING.—The Post Office authorities have decided to submit a vote to Parliament next session, to provide for the construction of a cable ship for the special service of the department. This is a step in the right direction.

THE ELECTRIC LIGHT AT MALTA.—The Eastern Electric Light and Power Company have received a telegram from their agent at Malta stating that the experimental lighting of the interior of the Opera House at Valetta with arc lamps was a complete success. The lights are on the Brush system, of which the Eastern Company are sole licensees for Malta.

CABLE INTERRUPTED.—The Great Northern Telegraph Company's Wladiwostock-Nagasaki cable is interrupted. Telegrams for China and Japan cannot, therefore, be accepted for transmission by this company's route until further notice.

PERSONAL.—It is worthy of note that the Danish Commander who has been for the last eight years and is now in command of the ss. "H. C. Oersted" is Captain G. Oersted, a grandnephew of Hans Christian Oersted, the celebrated Danish electrician.

TRAFFIC RECEIPTS.—The traffic receipts of the Western and Brazilian Telegraph Company for the week ending 30th December, 1881, were £2,147, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

TELEGRAPH WIRES IN SEWERS.—The *Operator* says that the district authorities of Washington have directed the removal of the telegraph wires recently laid in the sewers on account of their retarding the flow of water by gathering and retaining matter, which stops up the sewers.

ROYAL INSTITUTION.—The following papers have been settled for reading before Easter next, viz.:—Jan 20, "On Comets," by W. Huggins, F.R.S.; March 10, "Electric Lighting by Incandescence," by J. W. Swan; March 24, "Electric Railways," by Professor W. E. Ayrton, F.R.S.

ELECTRIC LIGHT IN PHILADELPHIA.—On the evening of Friday, Dec. 2, Chestnut-street, Philadelphia, was illuminated for the first time with the Brush electric light from the Delaware to the Schuylkill Rivers, a distance of $2\frac{1}{2}$ miles. The illumination has continued satisfactorily every night since.

THE TELEPHONE IN CYPRUS.—One result of the annexation of this island of wine-renowned fame has been the introduction of the telephone. An English firm of wine manufacturers have, it is said, connected their works at Mandria, an inland village, with the port of Limasol by a telephone line.

UTILISING TIDAL POWER AT BRISTOL.—The Bristol Corporation have resolved to spend £100 in obtaining the opinion of an eminent mechanical engineer upon the practicability of utilising the tidal power of the Avon and Severn for providing motive power for electric lighting and other purposes.

THE TELEPHONE IN HUDDERSFIELD.—The Huddersfield Corporation have for the last two months had a telephone line on trial between their gas works and the rate office. The instruments have given such satisfaction that it has been decided to rent them from the National Telephone Company (to whom they belong) at £10 per annum.

EXTENSION OF TELEGRAPHS IN RUSSIA.—A Reuter's telegram, dated St. Petersburg, the 4th January, says:—"It is officially announced that the Government have decided to establish telegraphic communication with Jakutsk. The length of the line between Irkoutsk and Jakutsk which would consequently have to be constructed is 3,000 versts."

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of December was 2,672, estimated to produce £2,500, against 2,284 messages, producing £2,494 in the corresponding month of last year. The traffic receipts for the month of October, estimated at £2,300, realised £2,192.

THE ELECTRIC LIGHT IN THE FRENCH SENATE HOUSE.—Experiments are to be made with the electric light as a

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means of illuminating the French House of Parliament at the Luxembourg. A committee has been appointed to conduct the experiments, and if they are successful the electric light will be definitely adopted for the meeting room of the Senate and some of the principal rooms at the Luxembourg.

Opening of New Telegraph Stations in China.—With reference to our note of last week on this subject, the Great Northern Telegraph Company announce that the following is a complete list of the stations which were opened in China on the 1st of January, viz.:—Soochow, Chinkiang, Tientsin, Chinkiangpoo, Chining, Lingching, and Taku. The fixed charge from this country to all these stations will be 9s. 2d. per word.

Sir David Brewster.—*L'Electricité* for December 24 gives a portrait of Sir David Brewster, whose centenary has just been celebrated in Edinburgh. Also a brief review of his researches in electricity and magnetism. Our contemporary reminds us that he was the first to publish (*Edinburgh Journal of Science*, 1828) an account of his friend Arago's researches on the influence of the aurora on a free suspended magnetic needle.

The Lowestoft Cable.—The Reuter's cable between Lowestoft and Emden, in Germany, which was broken last October, has been at length repaired, thus restoring direct communication by the Indo-European line with India and the East generally. The cable was restored on Saturday afternoon, the 31st December, by the Submarine Telegraph Company's ship, "Lady Carmichael," after an interruption of more than two months.

Alteration of Partnership.—Since the death of Mr. Richard Johnson, on the 16th of February last, the business of Messrs. R. Johnson and Nephew, of the Bradford Iron Works, Manchester, has been carried on by the remaining partner, Mr. John Thewlis Johnson. He has now taken into partnership his brother, Mr. James Clarkson Johnson. The style of the firm will, however, be continued as heretofore, and the management will remain the same.

The Telephone at Munich (Bavaria).—*La Lumière Electrique* says that the authorities of Munich contemplate the adoption of the telephone in that city. They have been making experiments with four of the telephones shown at the late Paris Exhibition by Mr. Paterson, of London, the result of which is that an exchange is to be established as soon as sufficient subscribers have been obtained. The annual subscription, or rent, is fixed at 200 marks, or £10.

New Telephone Company.—The certificate of incorporation of the Tropical American Telephone Company (Limited) has been filed in the office of the county clerk at Freehold, New Jersey. The object of the company is the construction and operation of telephone lines and exchanges in the several cities, towns, and villages in the West India Islands (excepting those of Cuba), Central America, Panama, Venezuela, United States of Colombia, British, Dutch, and French Guiana.

Honours for an Electrican.—To the names already given of gentlemen connected with the late Electrical Exhibition who have had various decorations of the Legion of Honour conferred upon them must now be added that of Mr. Aylmer, who has received the Order of Knight of the Legion. Mr. Aylmer is well-known as the honorary secretary for France of the Society of Telegraph Engineers and of Electricians. Everyone will agree that this gentleman deserves the compliment that has been paid him.

Electric Light for the Suez Canal.—There is a fair prospect of the Suez Canal being lighted by electricity, so that ships may pass through it at night, instead of coming to an anchor, as at present. Major Strutt, managing director of the Eastern Electric Light Company, is in Egypt, arranging with M. Lemasson, the engineer-in-chief of the Canal Company, for the lighting of parts of the canal by the Brush system, so that dredging operations may be carried on at night, instead of in the daytime. There is some prospect also of the lighting of the Suez Dock by electricity for the Peninsular and Oriental Company.—*Homeward Mail.*

Fire Alarms.—Some excitement was caused in Brighton the other day by a report that the Pavilion had caught fire. It appears that in removing some fire alarms connecting the building with the Town Hall, which had been placed in position experimentally during the recent Health Congress, one of the alarms was set in action. The apparatus worked so well that the fire apparatus was immediately turned out at the Town Hall, whilst a telegram was sent to the district stations for help. So speedily was this done that two hose-reels had started for the Pavilion before those at the building knew what was the matter. These fire alarms were evidently bent on a little private speculation in the advertisement line.

Organic Acids Produced by Electrolysis.—Some recent experiments in the production of acids by electrolysis have been made by MM. Bartoli and Papasogli. They used a water voltameter the electrodes of which consisted of retort carbon. These electrodes were attacked, and the liquid assumed a black colour. With 1,200 Daniell cells in constant action during one month, the liquid experienced an acid reaction, and mellic and hydromellic acids were obtained, as well as a black substance, composed of carbon, hydrogen, and oxygen, barely soluble in water, and insoluble in alcohol and chloroform. The same results were obtained with the use of several acid or alkaline solutions. When graphite was used the liquid was not discoloured.

A Grumble from Paris.—M. Delahaye, in the *Révue Industrielle* for the 28th December, complains that although "savants, engineers, and mechanics found a crowd of instructive and useful objects there, no efforts were made to interest the public" at the Electrical Exhibition. He goes on to say that the telephone, electric light, and so on, were fairly comprehensible and understood of the people, but that of other more incomprehensible articles no description whatever was vouchsafed, either in the catalogue, or by the exhibitors themselves, in the shape of leaflets or placards attached to the articles. As the Crystal Palace Exhibition will be largely patronised by the general public, exhibitors would do well to listen to this warning from Paris, and have some description of their exhibits ready.

Glasgow Telephone Exchange.—Mr. J. P. Quarles, the manager of the above Exchange, sailed on Saturday last, per ss. "Servia," *en route* for his native town of Richmond, Virginia, U.S.A., previous to filling an important post which we understand he has accepted with one of the extra-European telephone companies. Under the thoroughly practical management of Mr. Quarles the Exchanges in the Glasgow district have been extensively developed and brought to a high state of efficiency. Amongst other reforms introduced by this gentleman may be cited the keeping open of the Exchanges night and day, the abolition of cell power in favour of magnetos for calling purposes, the introduction of the Law system (of which he was one of the originators in the United States), and the total suppression of the disagreeable effects of induction on the longer lines. Mr. Quarles, on leaving, was presented with a handsome testimonial by the *employés* of the National Telephone Company.

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THE MAGNETISATION OF LIQUIDS.—M. Ziloff having magnetised a solution of perchloride of iron with a density of 1·52, found that its magnetic coefficient began by increasing with the magnetising force and then suddenly decreased. The maximum ·000142 corresponds to the magnetising force of 1·81 (taking as unity the horizontal component of the action of the earth). The apparatus used consisted of two magnetising helices of ·700 metre long, one of which was capable of holding the liquid. Two fine wire induction coils surrounded these two helices. A rotating commutator interrupted the magnetising current several times per second. By means of a Thomson galvanometer, the compensation of the current induced in one pair of coils, for that induced in the other, could be ascertained. This compensation ceased to exist when the tube-like helix was filled with liquid. The beat of the galvanometer needle enables the magnetic coefficient of the liquid to be calculated, and that of a tangent galvanometer introduced into the primary circuit enables the intensity of the magnetising force to be determined.

SULPHATE OF IRON BATTERY.—M. Wilbrant has constructed a battery, the depolarising liquid of which consists of a concentrated solution of sulphate of iron, the exciting liquid being a concentrated solution of sal ammoniac. The negative electrode is a carbon plate, and the positive a plate of amalgamated zinc; the liquids are separated by a porous jar, as in an ordinary Bunsen cell. The solution of proto sulphate is kept up by means of some extra crystals of sulphate. These cells will act regularly after some days' work. At first a reaction takes place, which agitates the exciting liquid and occasions the precipitation of oxide of iron. Once this has been done the ammoniacal liquid is left perfectly clear. It is necessary to apply paraffin to the tops of the carbon plates, and to grease the sides of the porous jars. According to M. Wilbrant, the action in this battery is as follows:—The ammoniacal solution is decomposed, and gives off ammonia; the chlorine and zinc combine and form chloride of zinc; hydrogen reduces the sulphate of iron and forms oxide of iron. Polarisation only takes place in this battery after the circuit has been closed for six hours, and depolarisation at the end of half an hour. The electromotive force is a little higher than that of a Leclanché cell.—*La Lumière Electrique.*

THE FAURE BATTERY.—M. E. Reynier has introduced some improvements into this battery. Having found that in the cells hitherto constructed there existed contacts between the plates, which gave rise to local currents, and that these caused the plates to deteriorate; and having also ascertained that the felt coverings became rotten after having been in use for a certain period, he was led to substitute for the felt a kind of woolly serge, which has given good results after several months' trial as regards durability. He now, therefore, covers his red lead coated plates with this stuff. He has also hit upon the idea of inserting his rolls of lead plates, &c., in transparent glass jars, in order to be able to notice the action of the cell without disturbing anything, and to see that the sheets are properly insulated. If there existed any contacts between the plates, gases would be given off; and, on the contrary, if none are given off, it would show that the cell was in good condition as regards insulation. The giving off of gases also takes place when the cell is sufficiently charged. In the first cells that were made gas was frequently given off almost without cessation. It may be concluded from this that they were imperfectly constructed. M. Reynier covers his cell up at the top, which prevents dust, &c., getting in.

AN INDICATOR OF A VESSEL'S COURSE BY NIGHT.—Mr. J. H. A. Macdonald, ex-Solicitor-General for Scotland, has just invented, under the name of "Holophote Course Indicator," an electric apparatus, the object of which is to diminish the risk of collision by night at sea. The indicator consists of an electric light with a reflector, which is fixed on a movable arm. When the helm is amidships the reflector throws the light straight ahead, the arm being held fast by two pegs, or detents, which are under the control of the helm by means of an electric connection. When the helm is ported, an electric circuit is formed, by which one of the detents holding the arm is depressed, leaving the reflector free to move, and then the light sweeps round to starboard with an action like the wave of a hand. When the light has gone round a certain number of points to starboard, a screen rises up and shuts it out from view, and the arm comes back to 'midships. If, on the other hand, the helm be put to starboard, the other detent is removed, when a movement exactly the converse of that above described will be performed. Thus the strong beam of the electric light is waved to one side or the other, indicating every alteration in the course of the vessel to all who may be within sight; and that at the instant that the course is changed. Under the ordinary method of showing red and green lights on port and starboard, a ship may swing round several points, while the distance is rapidly diminishing between her and another vessel, before those on board the latter can have any warning of the change.

QUICK WORK.—It was announced by the Mayor at the close of the Liberal Demonstration at Birmingham on Tuesday evening, that a telegram had been received from London to the effect that at twenty minutes past nine o'clock the whole of the verbatim report of Mr. Bright's speech had reached the metropolis. The despatch of the reports of Tuesday's meeting was the heaviest, but at the same time the most rapid, piece of work of the kind yet performed at the Birmingham telegraph office. There were 202 press messages of the proceedings, consisting of either full or condensed reports. In respect of these, 182,152 words were actually transmitted through the various wires, but as some of the reports were written out in manifold on reaching their destination the number of words delivered was 541,983. Mr Bright began to speak at 7:25 p.m.; six minutes later the first page of longhand manuscript was handed over by the reporter to the telegraph officials in attendance at the hall, and at 8:38 the despatch to London, Manchester, and other stations began. Mr. Bright sat down at 8:35, and the last page of shorthand writers' notes of the report for London was transcribed and despatched from the hall by three minutes to 9 o'clock. It was immediately "worked off" to London, whence the postal authorities acknowledged the receipt of the whole speech of 7,336 words at 9:20. Mr. Chamberlain's address followed, and afterwards Mr. Bright's remarks in thanking the Mayor. Mr. Chamberlain spoke 6,236 words. The despatch of the entire verbatim report was finished by 10:42 for Manchester, Bradford, and Liverpool; 11:5 for London; 11:15 for Leeds, Sheffield, and Edinburgh; 11:55 for Nottingham; 12:10 for Glasgow, and 1:6 a.m. for Dublin.

THE VARIATION IN THE RESISTANCES OF DYNAMOS.—M. Lacoine recently presented a note to the French Academy of Sciences on this subject. He thinks that the variations in the resistances of magneto and dynamo-electric machines with the increase in their speed is to be explained by the variations in the contact between the movable commutator and the spring brushes. To test this he made a copper

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cylinder ·05 metres diameter, with longitudinal grooves in it, resembling the insulating pieces of a Gramme commutator; two steel springs rubbed on this cylinder from two opposite points, and from each of these lead the wires of a circuit comprising a battery, a telephone, and a galvanometer, to measure the resistances. The resistance of the circuit was—

At rest	60	ohms
At a speed of 2,000 revolutions	183	„
Ditto 4,000 revolutions	900	„
Ditto about 5,000 revolutions	1,567	„
At a very high speed, which was not measured, from	2,900	„

The sound given out by the telephone was greater and sharper in proportion to the increase in the speed. At each speed the resistance diminished when the pressure of the springs was increased; in fact, a high enough pressure caused all noise to be suppressed in the telephone. Other experiments with slightly modified apparatus led to the same result. M. Lacoine is of opinion that for a given pressure of the springs the increase in the resistance is proportional to the cube of the speed; but, he adds, "it would be necessary for me to renew these experiments with apparatus which I have not got at Constantinople to be sure of a constant speed and exact measurement. I will conclude by saying that a more intense sound is heard in the telephone when the intensity of the current is not great; from which I conclude that the sound given out by a telephone placed in circuit with a Gramme machine is not caused by the wavelike variations in the current alone, but is also due to the microphonic effect of the commutator."

"Electricity and the Future."—Such is the attractive title of an able article by Mr. F. C. Webb, well known in electrical circles, in the January number of the *St. James's Magazine*. Mr. Webb in a few words takes us back to Faraday's researches into magneto electricity, and points out all that has since followed from his experiments. In speaking of dynamo-electric machines, the author makes some very interesting remarks on the enormous currents obtained by this means as compared with those got from ordinary batteries. We quote his words, which are as follow:—"Let us, for instance, calculate what number of Daniell elements (a class of element largely used, though in various forms, for telegraphic purposes) would be required to produce a similar current to that obtained from a Brush machine of the class specified by the Anglo-American Brush Electric Light Corporation as their 7A machine. Taking the figures given by Mr. Brush, the designer of this machine, it is stated, in the number of *Engineering* for February 4, 1881, that the electromotive force is equal to 839 volts. Now a volt is, roughly speaking, equal to about the electromotive force of an ordinary Daniell element. Consequently to have the electromotive force of this machine we should have to employ 839 Daniell elements, which alone would be a formidable battery, since even the single coils of gutta percha covered wire used for submarine telegraphy are never tested with more electric power than 500 such elements. But this is not all, we have to consider the resistance of the battery. Now the resistance of an ordinary Daniell element may be taken at about 5 ohms (the accepted unit of resistance). Consequently the resistance of such a battery would be five times 839 elements, or 4,195 ohms. But the resistance of the No. 7 Brush machine is said to be, by Mr. Brush, 10·55 ohms. Consequently, to obtain a similar current from Daniell elements, we must place in parallel circuit such a number of batteries of 839 elements as will reduce the whole resistance of the combined batteries to 10·55 ohms. To avoid decimals in calculation let us take Mr. Brush's figures for resistance of the 7A machine at 10 ohms, and then it will be seen, by Ohm's law, that to obtain an electromotive force of 839 volts, with the resistance in the battery of only 10 ohms, we must divide 4,195 by 10, giving 419·5 as the number of batteries of 839 Daniell elements each, that must be joined up in parallel circuit to give a current equal to a 7A Brush machine."

New Storage Battery.—A description of a new storage battery invented by Mr. Henry Sutton, of Ballarat, Australia, has been communicated to the Royal Society by the President. After a number of experiments the inventor found that by amalgamating lead plates with mercury a marked increase was immediately manifest in polarisation effects, the plates becoming more uniformly and rapidly peroxidised when used as positive electrodes, and local action entirely disappearing. Mr. Sutton's account of his experiments as communicated is as follows:—"The experiments comprised amalgamated lead as a positive electrode with negative electrodes composed of either zinc, iron, or copper, in each case the solution between the electrodes being a salt of the metal composing the negative electrode. With zinc, sulphate of zinc was the solution; with iron, sulphate of iron; and with copper, sulphate of copper. In all these cases the results were not only far more powerful than with any form of cell I had previously devised, but also very constant, the polarisation lasting many times longer than in any other form of cell. The cell with zinc negative electrode I discarded, owing to the necessity there would be to keep the zinc plate amalgamated to prevent local action; the iron negative electrode was set aside owing to the iron oxidising when the cell was not in use. The cell having a negative electrode of copper, a positive electrode of lead amalgamated with mercury and a solution of cupric sulphate, I have adopted as a thoroughly economical, lasting, and practical form of storage reservoir. The chemical changes in this cell are exceedingly interesting and beautiful, the cell being composed of a sheet of lead cleaned with dilute sulphuric acid and amalgamated thoroughly with mercury, and a sheet of thin copper a little shorter; the two sheets are perforated with a number of holes and then rolled in a spiral, separated by rubber bands cut every five inches, the holes in plates and cuts in rubber bands being to allow free circulation of the solution (the short plate being uppermost before rolling). This combination is immersed in a solution of cupric sulphate, and the amalgamated lead plate made the positive electrode of a suitable source of electricity, the chemical action being that the oxygen of the decomposed solution combines with the lead, forming a perfectly even coating of the insoluble peroxide, the hydrogen replacing the copper of the solution, and the copper being deposited in the metallic state on the negative electrode. As the decomposition of the cupric sulphate proceeds the solution gradually loses its azure blue colour, becoming more acid, and finally when the whole of the copper is deposited, we have the solution colourless and transformed into hydric sulphate and water, the positive electrode peroxidised and copper deposited on the negative electrode. During discharge the peroxide is reduced and the copper element oxidised, the oxide combining with the acid and forming cupric sulphate, the solution returning to its original colour. This change of colour forms a beautiful means of telling when the cell is charged; it is a veritable charging gauge. The power of this cell is very great and very constant; it can be made to last for hours, the time being dependent on the quantity of cupric sulphate decomposed."

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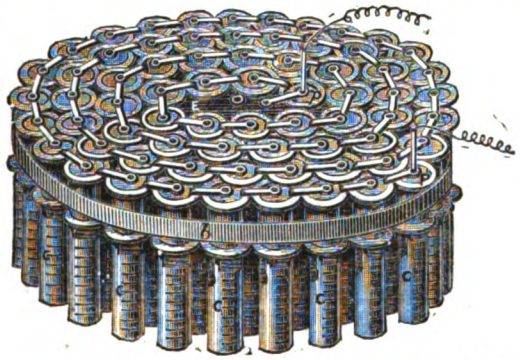
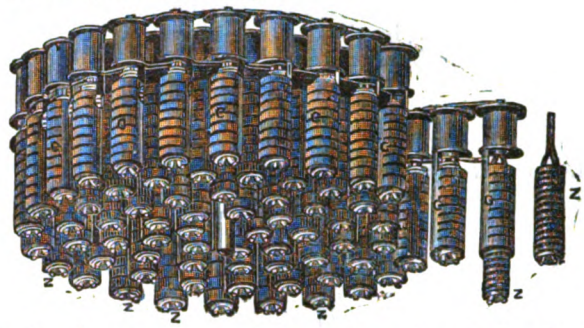
PULVERMACHER'S NEW POCKET BATTERY.

The distinguishing characteristic of the high-tension chain-battery recently brought before the *Académie des Sciences* by M. J. L. Pulvermacher is that the electrolytic communication between the elements, which hitherto has reduced the electromotive force of such batteries and prevented it from being even approximately proportionate to the number of elements, has been very perfectly obviated. In other respects also the new apparatus is an improvement upon the chain-batteries hitherto devised. The original Pulvermacher battery, with zinc and copper wires wound upon wood, dates from more than thirty years back, and a description of it is to be found in many of the French and German works on physics. (See Pouillet, "Eléments de Physique," sixième edition, tome I., p. 694; Daguin, "Traité élémentaire de Physique," tome III., p. 408; &c.) As in the case of the subsequent chain batteries formed of the same materials, the electromotive force of each element or link of the chain was about one volt; and, by reason of the "depolarising" action of atmospheric air, this electromotive force was far more constant when the circuit of the battery was completed than might have been expected with single-fluid couples of such small size. The next form of battery brought out by the same inventor was more "taking" in appearance, being externally constituted by hollow perforated cylinders of a golden colour, with projecting arms linking them together; but, from an electrical point of view, it is inferior to its predecessor, "local action" being encouraged by the contact of the aforesaid arms with the interior cylinders of zinc. Besides the above, various forms of "chain-band," similar in principle, but adapted more exclusively for medical use, have from time to time been brought forward. All these batteries are charged by being drawn through diluted acetic acid, or common vinegar; so that a continuous electrolytic communication is necessarily established between the poles of the electromotor. We do not suppose that, practically, this fact would constitute a great disadvantage in therapeutical applications; but, by rendering the difference of potentials very inconstant, it has not only detracted from the abstract value of a very ingenious and convenient form of high-tension battery but has prevented other applications in experimental science, telegraphic testing, &c., where such a battery might be a valuable addition to the resources of the electritrician.

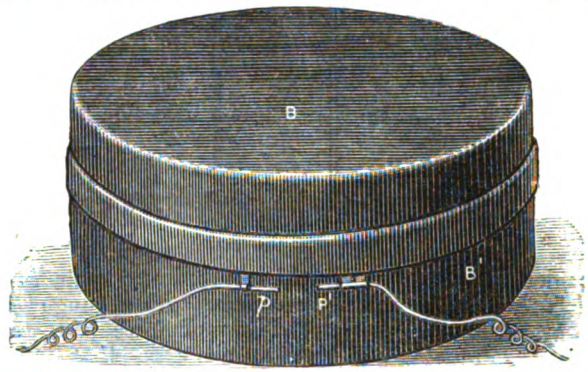


In the new form of Pulvermacher battery, which excited much interest at the recent Paris Exhibition, that portion of the chain at which the elements are connected together in series is kept clear of the exciting fluid when the battery is charged; so that, as we have above pointed out, there is no longer any electrolytic or fluid communication between the poles or indeed between any two cells of the battery. If, therefore, we do not obtain the full difference of potentials corresponding to the number of couples in series, the deficiency is due merely to that amount of conduction that can occur through the moist air intervening between the couples, and especially between the terminal portions of the chain. When necessary, this conduction can of course be reduced to a *minimum* by extending the chain in a straight line, instead of using it as arranged spirally in order to facilitate the immersion of the elements.

A battery of 69 couples of the new form is represented, as seen from above, by Fig. 1. The perforated hollow cylinders of gilt copper are shown at C C; whilst *b* is the caoutchouc band which, being slipped round the battery between the two grooved discs of insulating material which serve to separate each couple from those on either side, maintains the spiral arrangement. Fig. 2 represents the same battery as seen from below, showing the position of the zinc elements within the hollow cylinders of copper.



Lastly, the appearance of the battery when enclosed within the vulcanite box, of which the lower portion B′ may serve to contain the acid for charging the battery, is shown by Fig. 3.



It need scarcely be observed that B′ must contain no fluid when, for the sake of portability, the battery is thus enclosed.

An important feature in connection with these batteries is that every portion is stamped and formed by machinery, and that the manual labour requisite in making them up has been as far as possible reduced, a circumstance which influences very materially the cost of production.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

IV.

We have said that the electro-magnetic attractions experimentally observed by Œrsted and accurately investigated by Ampère may be summed up by the statement that a circuit carrying a current tends to enclose as many lines of force as possible; and the force urging the circuit to move as a whole, or to change its shape, or to move a portion of itself, will depend simply upon two things, viz., first, the strength of the current circulating in it; and, secondly, the rate at which lines of force can be added to or subtracted from its contour for a given velocity of the movable portion in any direction; and to each of these two things the mechanical force urging the conductor to move will be simply proportional.

It may be as well to put this into symbols:—

Let $\dot{N}$ or $\frac{dN}{dt}$ represent the rate at which lines of force would be added to the circuit if a portion of it were to move in any direction with velocity $\dot{x}$, or $\frac{dx}{dt}$. Then, if γ is the constant current, the force F urging the conductor to move in that direction is $\gamma \dot{N}/\dot{x}$, or $\gamma \frac{dN}{dx}$.

The work done or the change of energy during the small motion dx will be, of course, the force multiplied by the displacement; F dx that is, or $\gamma\, dN$.

Another way of expressing all this is to say that the potential

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energy of a circuit is equal to the strength of the current multiplied by the number of lines of force which thread the circuit, taken negatively.

$$P = -\gamma N.$$

Hence the work done, or potential energy lost, when the circuit is moved into any fresh position where it will include N′ lines, is $P - P' = \gamma (N' - N)$.

The average force exerted during the motion will be the work done divided by the distance travelled. Or, taking this distance infinitesimal and equal to $d x$,

$$F\,d x = d\,P = \gamma\,d\,N;$$

$$\text{or, } F = \gamma \frac{d N}{d x}.$$

Let us take a few examples of this very important theorem.

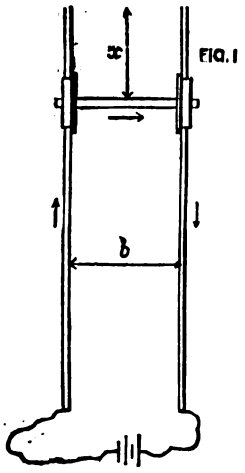
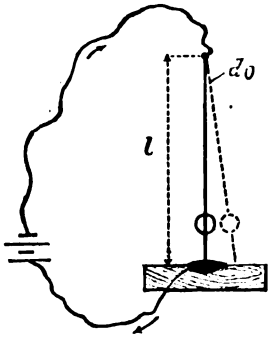


FIG. 1

Consider a pair of rails with an ordinary pair of truck wheels and axle rolling on them. The gauge of the railway call b, and let vertical lines of force pass through it to the number of V per unit area—that is, let it be in a uniform vertical field of force of intensity V. Join a battery (Fig. 1) to one end of each rail, and keep a current of strength γ circulating through the rails and along the axle. Then, if the axle were to roll through a length x, the fresh lines of force enclosed would be $V\,b\,x$, and hence the change of energy or the work done would be $\gamma\,V\,b\,x$. Hence the force urging it so to move is $\gamma\,V\,b$.

FIG. 2



Again, take a pendulum of length l, in a uniform horizontal field of intensity H, and let the bottom of it dip into mercury or something to make contact, and to permit of the current γ being sent along it. Then it is the movable part of a circuit, and if it swing through an angle $d\theta$ (Fig. 2) would sweep out a sectorial area $\frac{1}{2} l^2\,d\,\theta$, adding, therefore, to the original lines of force the number $\frac{1}{2} H\,l^2\,d\theta$; wherefore the moment causing the swing is $\frac{1}{2} H \gamma\,l^2$. (Or the equivalent force at the bottom of the pendulum is $\frac{1}{2} \gamma H\,l$.)

In this case the motion can only be small, because the least motion will break the circuit and allow the pendulum to fall back again.

Instead of a pendulum, consider a disc (Fig. 3) supported at its centre by one contact, and dipping its rim into mercury for the other contact, and with a field of force of intensity I perpendicular to it. Then one radius of the disc will be just in the condition of the pendulum, and may be thrown out of the mercury directly the current passes; but it will now have no tendency to swing back again; on the other hand, another radius instantly takes its place, and is in its turn thrown out and replaced by another, and so on; so that the wheel is continually urged to rotate with the moment $\frac{1}{2} r^2 I \gamma$.

This is an interesting case, because the number of lines of force is never really increased by the rotation. It is only a perpetual tendency to increase them, and this keeps up a perpetual rotation. If the lines pass through the circuit in the other direction the tendency to decrease them will cause the wheel to rotate in the other direction.

It is also interesting as being the simplest electromagnetic engine known, and the first magneto-electric machine ever made (Faraday, 1831).

In this experiment the rim of the wheel may be made contact with at more than one point; or it may be touched all round, so that the centre of the disc is one electrode, and the whole rim the other. It will make no difference to the force urging it. Hence the experiment may be put in one or two less obvious forms, such as a horizontal wire supported on a pillar in the middle, and dipping both or either end into a sulphate of copper circular trough; or it may be an inverted basin dipping its rim into acid, and pivoted at its centre. All these things will rotate if immersed in a magnetic field so that the lines of force pass through the rotating portion once (or any odd number of times).

The important fact may here be noticed that in no case is it possible to keep up a continuous rotation unless there is some rolling or sliding contact; for a single connected circuit can only expand to its greatest size, it cannot be adding lines of force indefinitely. Hence in all machines some moving contact is an absolute necessity.

FIG. 3

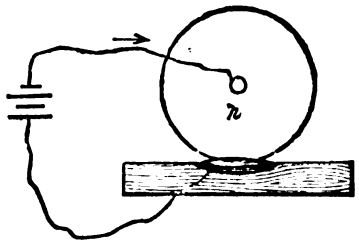
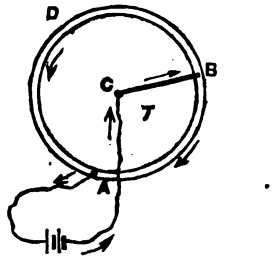


FIG. 4



Beginning with a rotating wheel touched at one point of its rim we have passed to a wheel touched all round its rim, and from this to a rotating radius making contact with a circular ring surrounding it, such as a mercury trough. But it is interesting to consider this last case separately. The circuit is of constant area, and, on the whole, the number of lines passing through it is therefore constant; but it is divisible into two portions, A C B and A D B C, in one of which the current encircles the lines clockwise, and in the other counter-clockwise (Fig. 4). Hence one of these areas is always tending to increase, and the other to decrease; *i.e.*, the movable arm C B continually revolves, the point B moving contrary to the hands of a watch if the lines of force go downward through the circuit as the earth's lines do. The rotating moment is $\frac{1}{2} r^2 I \gamma$. The lines added to the area A C B are subtracted from the area A D B C it is true, but, by reason of the opposite sense of the currents, both the addition and the subtraction assist the motion.

In all these arrangements the necessary lines of magnetic force may be produced in various ways. If the earth's lines alone are utilised the moving tendency will be exceedingly small and may be overlooked. It may be strengthened by bringing one pole of a magnet near the moving portion, or better by putting the north pole of a magnet on one side of the moving portion, and a south pole on the other. Or it may be done in the case, say, of Fig. 4, by wrapping round the circular trough a fixed coil of wire conveying a current (which has lines like a magnetic shell we know); or again, we may put a bar magnet right through the circuit so that its axes all pass through it. But in this

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last case it will be obvious, on consideration, that the magnet must be able to rotate or nothing can; and the lines of force practically cut by the circuit at each revolution are the whole number produced by the magnet minus those which pass in the reverse direction in the air between the magnet and the ring trough. It does not matter whether the magnet is placed centrally in the ring trough or otherwise, and the arrangement will be recognised as one of Faraday's very ingenious devices for showing that a magnetic pole rotates round a current.

THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.*

(*Continued from page* 102.)

The Transport of Mechanical Energy.

In the foregoing parts of this article we found that, whether the work done by a current be chemical or thermal, the quantity $Q = E I$, and we shall now see that this formula is general.

Consider the circuit in Fig. 3, consisting of a battery, P, of n elements, a galvanometer, G, for measuring the intensity of the current, and between the points H and B a series of apparatus, C C′ C″, expending current either as heat, chemical action, or motive power. The galvanometer will indicate an intensity I, and Z quantity of zinc will be burned in each element, or n Z in

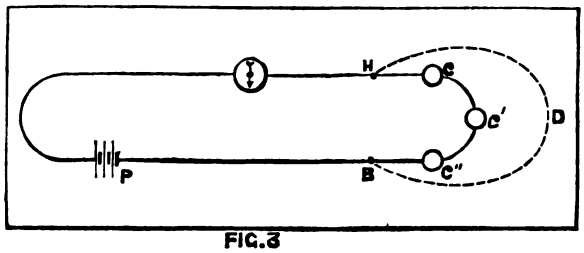

FIG. 3

the whole battery. We will now substitute for the apparatus C C′ C″ a simple wire, H D B, whose length we can vary until the current is brought back to its former intensity I. Now, since in the latter case the total energy generated in the circuit is, as we have before seen, represented by E I, where E is the electromotive force, which is constant, it follows that, as I is the same in both cases, the expression E I also gives the energy generated in the case of the circuit, when C C′ C″ takes the place of the wire H D B.

Moreover, we know that the difference of potential between the points H B, the ends of the wire H D B, is e, and that the energy expended in that wire is e I; therefore, since both e and I remain unaltered when the apparatus C C′ C″ takes the place of the wire, it follows that e I must represent the energy expended in these apparatus too.†

It results from the above demonstration that an active resistance can always be replaced by an inert resistance. The value of this resistance, x, is easy to find.

If E is the positive electromotive force, e the negative electromotive force, and R the resistance, we have

$$\frac{E - e}{R} = \frac{E}{R + x},$$

from whence $x = \frac{e R}{E - e}$, and by substituting x for e the state of the circuit would be unaltered.

Let us apply these considerations to a circuit where only heat and mechanical energy are developed. Calling E the electromotive force of the generator, it is to be noted that E is supposed constant, as well as all other electromotive forces in the circuit. If this were not premised, the problem would require the help of the integral calculus. With E constant we have, in accordance with the principle of the conservation of energy,

$$E I = R I^2 + T,$$

where E I is the total energy generated, R I², after Joule's law, is the total heat produced, and T the motive power to be utilised. The intensity I is a variable depending on the value of T. It is obvious that if $T = 0$, and the current only produces heat, $E I = R I^2$, whence may be deduced $E = R I$, which is Ohm's law.

The intensity I can be determined by evolution from the equation of the second degree

$$R I^2 - E I + T = 0,$$

whence $$I = \frac{E \pm \sqrt{E^2 - 4 R T}}{2 R}.$$

Let us examine the different values of I for different values of T. The expression has the double sign ±, and we will first take the sign +.

If we make $T = 0$, we will find $I_0 = \frac{2 E}{2 R} = \frac{E}{R}$, the intensity which will develop in an ordinary circuit, without apparatus for producing motive power, and the maximum intensity obtainable in a given circuit. If we make T increase, the value of I will diminish; but we see that T cannot pass a certain limit, as, the quantity under the root not becoming negative, the maximum of T will be obtained for $E^2 - 4 R T = 0$, from whence we have $T = \frac{E^2}{4 R}$. For this maximum value the value of I will be $I_1 = \frac{E}{2 R} = \frac{I_0}{2}$. The intensity corresponding to no mechanical work done is therefore reduced one-half when the work done is a maximum.

Between these two values the intensity I may be considered as the maximum intensity I_0, diminished by a certain quantity. We may write, then, $I = I_0 - i$. Now I_0 is, as we know, equal to $\frac{E}{R}$, and we can put the variable quantity $i = \frac{x}{R}$. Thus we have

$$I = \frac{E}{R} - \frac{x}{R} = \frac{E - x}{R}.$$

We see that the quantity x presents itself as a diminution of the electromotive force of the battery, and behaves as a negative electromotive force. Accepting this interpretation, and calling it e, as before, we find

$$I = \frac{E - e}{R},$$

a formula to which we have already been led in studying the transport of chemical and thermal energy. The value of e is otherwise easy to find. We can put

$$\frac{E - e}{R} = \frac{E \pm \sqrt{E^2 - 4 R T}}{2 R},$$

whence we have $$e = \frac{E \pm \sqrt{E^2 - 4 R T}}{2}.$$

From all this we see that known principles lead us without any experiment to conclude that the presence of an electric motor in a circuit is equivalent to the presence of a negative electromotive force. This result has long ago been proved by experiment, and the transport of mechanical energy is only a particular case of the transport of energy in general, and obeys the same laws.

Returning to the general formula $E I = R I^2 + T$, we have $T = E I - R I^2$, where E I is the total energy generated. The economic yield, K, is $\frac{T}{E I}$. Hence we have the formula,

$$K = \frac{T}{E I} = \frac{E I - R I^2}{E I} = 1 - \frac{R I}{E},$$

which can be written $$K = 1 - \frac{I}{\left(\frac{E}{R}\right)},$$

but $\frac{E}{R}$ is I_0, hence $K = I - \frac{T}{I_0}$.

On the other hand, we know that

$$I = \frac{E - e}{R}, \text{ therefore we have also}$$

$$K = 1 - \frac{\frac{E - e}{R}}{\frac{E}{R}} = \frac{e}{E}.$$

Hence, whatever be the nature of the energy transported, the economic yield or efficiency is expressed by the ratio of the negative electromotive force developed in doing useful work to the total electromotive force necessary to produce the energy expended.

(TO BE CONTINUED.)

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* From a paper by M. Marcel Deprez in *La Lumière Electrique*.

† To find this energy in kilometres, it is necessary to express E and e in volts, I in ampères, and divide the product by the number $g = 9{\cdot}81$.

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THE ELECTRICIAN.

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1881.

The year that is just passed has been the most important in the history of electric lighting, and it may be in the applications of electricity generally. Before, however, commencing our sketch of the history of electrical progress through the year we may be allowed to say a few words about ourselves. The future and not the past will form the staple of our remarks. In addition to the articles now appearing "On the Theory of Dynamo, &c., Machines," which are written by a gentleman whose name would be a guarantee of ability to cope with such a subject, we shall commence in our next number a series of articles by F. C. Webb, M.I.C.E., on "The Electric, Conductive and Inductive Circuits," geometrically illustrated. These articles will, perhaps, convey to Mr. Flanery and others who think with him, some idea of how we on this side the Atlantic look upon the essentiality of "circuits." We shall see further on that one of the most important applications of electricity during the past year is in the direction of storage. In order to be able to give our readers full and authentic information on the subject of storage batteries and their application to incandescent electric lighting, we are having a small vertical steam engine, dynamo machine, and lamps fitted up to test their utility in houses of moderate dimensions. The details of the experiments will be given in due course. Lastly, so far as concerns ourselves, we have arranged with Mr. Van Nostrand, the well-known American publisher in New York, to become our agent in America, and any of our friends in America desirous of subscribing or advertising will be able to obtain full information from the agent. Special articles will be written by the electricians of America, for science is cosmopolitan, and although we belong to the old country we cannot fail to see that our scientific colleagues in America are quite able to render us very valuable information. The present issue is increased with the supplement to eight pages over and above our usual size, but we are quite prepared to increase our size as required.

Last year our review of the previous year's work extended through two numbers, and we find ourselves compelled to extend our report of last year's work in a similar manner. In the annual report last January we noticed telegraphy first, and electric lighting next, but we must now reverse the positions, and deal at once with the latter, as showing the most important development during the year. We have no partialities among the systems of electric lighting, and the systems are mentioned just as the information comes to hand.

In 1876 the Jablochkoff lamp was invented, and in 1878 the Paris Municipality, during the time of the International Exhibition, lighted up several streets, and brought the possibilities of the electric light into prominence. Electricians in all parts of the world turned their attention to the improvement of the apparatus employed, but the Jablochkoff lamp was the first used on a large scale. During 1880 the company owning the lamp seems to have done little, but during 1881 they have performed a very large amount of work.

In April last they entered into a contract with the Metropolitan Board of Works for continuing the lighting of the Embankment and Waterloo Bridge for three years. This, after exhaustive experiments extending over two and a-half years without a single failure, and during the time when several new forms of electric light were on trial in other parts of the metropolis, and thus afforded opportunities of judging their respective merits, should be one of the most satisfactory events of the year to the company. New works, in pursuance of this contract, will be erected as soon as the plans, &c., have been finally approved by the officers of the Metropolitan Board of Works, which will probably be the largest, as they certainly will be the first, in this country in connection with any lengthy contract.

During the year Mr. W. Whiteley, of Westbourne-grove, introduced the Jablochkoff light into his warehouses. Messrs. Samuel Brothers, of Ludgate Hill, who, after the fire which destroyed their premises (where Jablochkoff had been some time in use) had been persuaded to try another form of electric light, have resumed the Jablochkoff lamp. Messrs. Shoolbred and Co. have increased the number of their Jablochkoff lamps from forty to sixty. Messrs. Smith and Saunders, the proprietors of the Bon Marché, Brixton, have just introduced the Jablochkoff into their warehouses. Meanwhile, all the old consumers continue its use—the best refutation, as far as Jablochkoff is concerned, of the assertion of the *Journal of Gas Lighting*, in a recent number, that electric light companies appear more successful in getting new clients than in keeping old ones.

In 1881 the Société Générale d'Electricité entered into contracts to light for ten years the harbour and docks of Havre with Jablochkoff, and for a like period the Railway Dock and basin of Antwerp, both important works, which, added to the Metropolitan Board of Works referred to already, affords evidence of the practical development of the electric light on a large scale.

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In 1881 the Société Générale d'Electricité became the Compagnie Générale d'Electricité, the capital being increased from £300,000 to £800,000.

Upwards of 2,000,000 candles were sold in 1881, the price having been reduced from 4s. to 3s. a dozen—a natural consequence of the increased demand (it was 7s. a dozen in 1878). It is not improbable that before very long it may be further reduced to 2s. 6d., or even 2s. On the other hand, the scientific staff of the Compagnie Générale are unremitting in their endeavours to improve the quality and duration of the candle, which would, of course, amount to further reduction in the price; and this result is not unlikely to be obtained, when it is remembered that the first candles made lasted hardly half an hour, whilst now they last over two hours. The year 1881 has also witnessed the completion of the Jablochkoff dynamo-machine, specially designed to work in connection with the candle, which will tend considerably to the economical working of the system. A full and illustrated description of this machine will be given as soon as space permits.

The following is a list of recent installations of this lamp :—

Paris.—Théatre National de l'Opéra, works of the Paris, Lyons, and Mediterranean Railway (Rue St. Anne); rebuilding of the Grand Magasins du Printemps, workshops of Messrs. Chaligny, Guylot, Sienes; workshops of Piat, workshops of Baudet, workshops of General Omnibus Company, building yard of Messrs. Perret and Co., Grands Magasins du Louvre (48 extra lamps), works of Messrs. Tincotti, stables of the Messageries Nouvelles (Place de la République), Café Concert du Panorama, foundry of Messrs. Thisbaut Frères, workshops of Messrs. Descleris (silversmiths), works of Messrs. Varall, Eskill, and Middleton.

The French Provinces.—Works of Messrs. Grigoire Frères (Crèvecœur), works of Messrs. Japi Frères (Beaucourt), works and mines of Montchanin, works and mines of Courbetton, near Montchanin; works of Messrs. Deflassieux, Rive de Gier; works of La Buire, second order; casino of the Public Gardens (Pau), works of the Weirs (Anisy le Chateau), works of Farcot, St. Ouen; works of the Weirs at Sureune, works of Laduret (Pantin), mills of Messrs. Abel Leblanc (Pantin), Rolling Mills and Steel Works (Ivry), works of Mons. Lemoine (Ivry), National Company of Building Railway Plant (Ivry), Sugar Refinery of Nantes, Military College of St. Cyr, School of Arts and Manufactures of Angers, works of the Dyle, Bordeaux; works of Messrs. Simonnet, Reims; works of Messrs. Pengeot, Reims; Carpet Manufacturers, Letaell (Beauvais); Ironclad "Amiral Duperré," Toulous; harbour deepening works at Dieppe.

Continental Countries, except France.—Messrs. Nicaise and Deleuve; works of the Bridge of Heumen les Mook; Café Krasnapolsky, Amsterdam; Rooseboom Magasin, Rotterdam; works and workshops of Société de la Dyle et Bacalam Louvain; Flax Mills of Vandermissen at Alost; collieries of du Poirier, Montigny-sur-Sambre; building works of Messrs. de Naeyer, Willebrocsk; Messrs. Schubeck and Plentz, Hamburg; Rolling Mills de Wendel, Hayange (third order); Messrs. Bally, boot and shoe manufactory, near Aaran, Switzerland.

The British Electric Light Company was, we believe, the first company formed for electric light purposes in England, and as they possess the Gramme patents for the United Kingdom, necessarily hold a prominent position among such companies. During the past year several changes of considerable importance have taken place in the *personnel* of the Company's staff. Mr. Wills, the secretary, and Mr. Ward, the engineer, having resigned, Mr. Milne became secretary, and Professor G. Forbes accepted the post of general manager. The scientific ability of Professor Forbes is well known, and we heartily wish him success in his new undertaking. At the beginning of the year the Company took a large block of buildings in Heddon-street, Regent-street, and since that time they have found it necessary to take another large block of equal size to meet the demands of their business.

This Company will undertake the installation of any system, but they have incandescent and arc lamps of their own which they naturally prefer. The incandescent lamp is called the British Incandescent Lamp. It is used in part of the General Post Office, and in various places around Heddon-street. A step in the right direction has been taken in the formation of a central station for the generation of the current at Heddon-street. Thus the Scottish Club in Dover-street, Piccadilly, for some time past has had the current turned on from Heddon-street at 3 p.m., and the Club is illumined till 2 a.m. when the current is turned off. This Company have the Brockie arc lamp, as seen at Cannon-street. Mr. Brockie has lately, however, made improvements in it, and thirty lamps of the new pattern, as well as the incandescent lamps, will be exhibited at the Crystal Palace. Mr. Brockie's lamp is one that adjusts itself periodically. In his lamps of recent design he employs two solenoids or magnets, one in a main circuit, the other in a shunt circuit, and it is in the relation and duties of these solenoids that the pecularities of the lamps consist.

The Electric Lighting Supply Company has, under the superintendence of Mr. Killingworth Hedges, C.E., installed his light at the Liverpool Docks. The lights are on lattice work poles 80ft. high. They have been working some time. It has been found necessary to mask the entrance light on the river side, and to tone it down at the entrance, which consists of a passage between two piers. This has been done by means of a bonnet-shape reflector, which causes the greatest amount of light to be concentrated about 20 yards from the light where the first set of locks are. The lattice-work towers have stood the exceptionally heavy gales without injury, which is probably owing to their massive foundations of cast iron, embedded 10ft. deep in concrete.

At the Ipswich Docks, where the lighting has been carried out by the above Company, the electric light is now used almost nightly on both sides of the dock by means of a cable, 220 yards long, laid along the bottom of the dock. No difficulty is found in maintaining the three arc lights in the circuit. The machine used is the Franklin (Bürgin patent), and the Andrew's lamps. It hardly comes within the province of this review to mention that any particular lamp or machine has been exhibited at this or that exhibition, but we may say that almost all the machines and lamps mentioned in this article have been exhibited at Paris, many at the Smoke Abatement Exhibition, and most will be exhibited at the Crystal Palace. At Paris we fancy all machines and lamps gained prizes of some kind or other. Inconsiderate people have said the prize depended solely on the lamps being in action or not.

The Northern Electric Light Company has its home in Dundee. It has but lately been floated, and little time has elapsed for much business to have been done. We believe, however, that several installations are in hand, the systems employed being those of Crompton and Brush.

The Dublin Electric Light Company.—This company was registered in June last. They have established a station in a central position, from which they are doing a consider-

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able business. Owing to the Corporation having refused to allow cables to be laid underground—because it involved the breaking up of streets—work is somewhat limited. Parliamentary powers are to be asked for, and, if these are obtained, we trust our next review will contain the details of a large amount of work.

The Electric Light and Power Generator Company, when the Jablochkoff Company, owing to some legal questions, were unable to carry out the agreement as to the lighting of part of the city of London, undertook the work. The portion lighted is that from the Mansion House to Blackfriars Bridge, *viâ* Queen Victoria-street, Southwark Bridge, and Queen-street. The central station is at Bankside. The machines and lamps used till lately were those of Weston. There were 32 lamps on four circuits of eight each; but these lamps being designed to burn for a comparatively short time, are being replaced by lamps intended to burn for 16 hours. The Weston lamps are used at the Moorgate-street, Aldersgate-street, and Farringdon-street stations of the Metropolitan Railway. This Company has recently purchased the Maxim incandescent lamp, and have been preparing to manufacture on a large scale. Some of the Maxim incandescent, and some of the Weston arc lamps are in use in the Post Office at Edinburgh, and lamps and machines have been, or are being supplied for use in Her Majesty's ships "Agamemnon" and "Polyphemus." The general opinion is that the Maxim lamp is very good, and we believe the Company are prepared to guarantee a minimum lasting power of 600 hours. Quite recently Mr. Massey has been appointed general manager of this Company, and from what we can glean of the career of this gentleman, his motto seems to be "thorough." Mr. Crookes is consulting electrician to the Company, and although we do not acknowledge his pre-eminence as an electrician, indeed we should think he would disclaim the title, his chemical knowledge has led him to investigate the properties of carbon required for the incandescent light, and to prepare carbons which are said to be superior to anything hitherto described. Mr. Crookes has recently taken out two patents, one of which is published, but the second is said to contain the most important claims in the invention.

The electric light companies that have become most prominent, and among whom the greatest portion of the work of the year has been distributed, are the Brush Company, Crompton Company, and Messrs. Siemens. We give these companies or firms, if it is found preferable so to distinguish them, the short name by which they are generally known. Previous to 1881 the work undertaken by electric light companies was of no very difficult character; but during 1881, owing to the progress made with the incandescent light, of which more hereafter, experimental and practical work of a very onerous nature was successfully carried out. Mr. Crompton, for example, with characteristic energy and ability, determined to prove the adaptability of the incandescent light to mining purposes. He undertook, under the auspices of the Mines Accidents Commission, to show the lamp in actual use, and this experiment was successfully carried out at the Pleasley Colliery, near Mansfield. Subsequently Mr. Crompton made a complete installation at the Risca Colliery—a mine rather well known as among those classed as dangerous. After the experiments at Pleasley, Mr. Watson determined to use the light at the Earnock Colliery, Glasgow. The work was carried out by Messrs. Graham, of Glasgow, with the co-operation of Mr. A. Jamieson, Principal of the College of Science; and we understand that the experience gained with the Swan lamps used has shown that they possess a lasting-power of at least 700 hours, an experience of great interest, showing that our idea of a lasting power of 1,000 hours is likely to be realised within a very short period.

Messrs. R. E. Crompton and Company have carried out and completed, among others, the following installations of electric light machinery during the year 1881 for:—King's Cross Station, Great Northern Railway; Bricklayers' Arms Station, South Eastern Railway; North British Goods Station, Glasgow; Norwich Market Place and several streets; Petroleum Works, Novorosüsk, Caucasus; steamship "Cotopaxi;" steamship "Cachapotl;" Norman and Sons, Barrow-in-Furness; Belfast Harbour Commission; William Spottiswoode, Esq., F.R.S., Combe Bank; Risca Colliery Company, South Wales; Broadway Damask Company, Belfast; Ripley and Sons, Bowling Dye Works; Colliery at Zamkeroda, Germany; Rotherwood Steel and Iron Company, Rotherham; Appleyard's Tannery, Hunslet Carr, Leeds; Stockton Forge Company; Messrs. Furlong and Company, Cork; Professor Crookes, F.R.S.; Messrs. Tate, Silvertown; Messrs. Greenhill, Belfast; Messrs. Harland and Wolf, Belfast; Messrs. Vernon and Ewens, Cheltenham, and other sets of apparatus for Australia, &c. The firm has carried out temporary installations at the opening ceremony Hull and Barnsley Railway, the *fête* at the Horticultural Gardens, at the Society of Arts (twice), at the United Service Institution, at the opening of the Ipswich Fish Exhibition, also at the *conversazione* at University College (twice), at King's College, and in the town of Ipswich. The lights were used at the Fine Art Exhibition, Wakefield, for two months, at Holyrood Palace during Her Majesty's visit to Edinburgh three weeks, at Greenock Harbour for two months, at the town of Dewsbury, at McElroy's, Reading; at the Banquet to Mr. Gladstone at Leeds; at Belfast, &c. Among the work in hand and nearly complete we may mention the Mansion House Egyptian Hall and Saloon; Messrs. Vickers and Sons, Sheffield; Messrs. Furnivals, near Manchester; Harbour Works, Fraserburgh; Dennystown Forge Company; Messrs. Lawson and Best; Northern Electric Light Company, Dundee (second order); Messrs. Brown Bros., Edinburgh; Messrs. Phillips Bros.; Messrs. Tate, Silvertown (second order); Thomas Littlewood, dyeworks, Huddersfield; Messrs. Love and Company, Glasgow; experimental works for the Editor and Proprietors of *The Electrician*, &c.

We shall be compelled to close our *resumé* of electric lighting operations this week with a brief notice of the Brush Company's operations, leaving the consideration of the most important work—viz., that of incandescent lighting, till next week, as well as the work of other companies. The Brush Company has a capital of £800,000, of which £400,000 has been issued. The general manager is James Humphreys, Esq. The forthcoming annual report of the Company, with a proof of which we have been favoured, says:—"The number of lights already sold for use in the United States is 5,500, some of which are of 3,000 and the remainder of 2,000 candle-power." These, together with the lights in use in England, &c., form an aggregate which is thought to be far in excess of the total amount of electric lighting by other systems combined. In the current number of the *St. James's Magazine*, Mr. F. C. Webb has made a calculation, showing that the Brush machine (No. 7) is equivalent to over 350,000 Daniell cells. This machine is said to supply current to 16 arc lamps, with an absorption of 14 horse-power. Our contemporaries, the papers devoted to gas interests, are in a somewhat similar plight to the man who has eaten too much lobster for supper—rather crabbed. They evidently desire to veer round, so as to become the organ of electric lighting interests, for their columns are from week

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to week devoted more largely to the subject. Yet, feeling that the electric light may possibly be a failure, and that it is impolitic to be off with the old love before safely on with the new, they never hesitate to question the accuracy of the figures as given for the cost of electric lighting. The statement, however, that the cost of electricity (not including first cost) is £134 3s. 8d. at South Kensington, where 16 Brush lamps are used, against £560 for gas, is a matter which is unassailable. Even when the interest on first cost is considered, Lieut.-Colonel Festing reckons the yearly saving at £325 16s. 4d.

Turning now to the telegraphs, controlled by the Postal Telegraph Department of this country, the chief items of progress consist in the completion of the new main lines to the north of Great Britain and the extension of telephonic communication with the licence of the Postmaster General, or under his actual control. Several additional local companies have been formed in order to afford telephonic exchange facilities since the settlement of the dispute between the original companies and the Government, whilst the Government itself has erected lines specially for telephonic working between several groups of important towns adjacent to each other. The additional trunk lines to the north referred to above have been supplemented by shorter but hardly less valuable extensions in the south and south-west. The means of communication between London and Bristol, London and Plymouth, and their outlying neighbourhoods, have thus been largely augmented. The part taken by the Postal Telegraph authorities in the Electrical Exhibition deserves also a passing word of praise. Their arrangements were the more creditable because of the lukewarm support afforded them by the Treasury, and we are glad to see that this has been recognised by the French Government, who have conferred upon Mr. E. Graves and Mr. W. H. Preece the distinctions respectively of Chevalier and Officer of the Legion of Honour. On the whole, however, the year has been one of difficulties and disasters for the postal telegraphs of this country. Early in January a snowstorm of almost unprecedented magnitude and extent impeded communication for several days, causing considerable damage to property, besides loss of traffic. The spring gales were also of unusual violence, and have recurred again during the autumn and winter months, doing great mischief to telegraph lines in one quarter or another, sometimes in many simultaneously, on each of these occasions. The cables between England and Ireland appear to have suffered least, but the short lengths connecting the Shetlands, Islay, and Scilly respectively with mainland gave way early in the year, and only the Islay cable was repaired without many months' delay. The want of a Departmental cable ship is the cause of this and many other serious inconveniences connected with the repairing and laying of submarine wires, and we trust that the lessons of the past year will not be thrown away upon those who are responsible for the helpless condition to which this branch of the service is so frequently reduced. Notwithstanding these drawbacks, however, and the unavoidable difficulties attending the settlement of the claims of the whole staff of telegraphists—claims which at one time threatened to be pushed to the extremity of a strike—the traffic and revenue have steadily increased month by month when compared with preceding years. Partly because of this increase, and partly because of the reorganisation consequent upon the settlement just referred to, a considerable augmentation of staff has taken place and is still being carried out.

Our account of cable and other electrical work of the past year must be deferred till next week.

CORRESPONDENCE.

"CIRCUIT."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leader for 22nd October exception is taken to the statement "there is no circuit," made by a writer in *Harper's Magazine*, and you say broadly, "there is a circuit, and the thesis of the writer in *Harper's* will not bear discussion."

Since then six or seven numbers of *The Electrician* have come to hand, but contain nothing *pro* or *con* on the subject. From this it seems fair to conclude that you have given expression to the common belief. You have great names on your side, men whose word, in a matter not coming daily under my observation, I should accept without any hesitation.

Doubters are necessary, if not essential, to the world's progress or welfare. Not the silent doubter, but the one who speaks his mind. Be this as it may, one who speaks his mind to one who is able and kindly willing to instruct him benefits himself and helps others under such circumstances as the present.

When I learned telegraphy many years ago I was taught that "the current passed from the battery along the wire to the distant station, where it entered the ground and returned thence through the earth to the other end of the battery whence it started." This is and always has been the definition of "circuit;" it is clear and simple enough, and it is substantially what we understand from Professor Fleeming Jenkin, who says that when positive electricity is lifted from the earth an equal quantity of negative electricity moves to the distant station; which is only saying, I take it, that earth electricity in a narrow stream moves from the distant station to take the place of that lifted from the earth and sent along the wire. This may be likened to a narrow stream of water across an otherwise quiet lake.

Mr. Robert Sabine says when electricity is lifted from the earth, its negative hovers near, and follows it till finally they come together. This requires the negative to follow the wire in all its windings, and, except in this particular, does not differ from Professor Jenkin's explanation. One might accept either as long as there was but one wire; but, considering the great number of circuits of which the earth is a part, and the certainty that the currents must meet in it; and, moreover, when one studies the earth-connection in a large telegraph office, where are seen numerous battery poles, positive and negative, connected to a single earth-wire, down and up which according to the theory currents are flowing, such an explanation must be rejected.

It is said that the batteries in a large station support one another, and that the earth-wire acts as a drain for the overflow or surplus current; but one cannot see to which of the distant stations the surplus goes, or whether it divides out, a part going to each one. If it goes, it must meet with other currents, and therefore takes rank with the other explanations.

In such a station working eighteen or twenty circuits, all lengthy, I have seen the ground wire broken, between the point where all the batteries were connected to it and the earth plate, without any interruption or any of the operators noticing the change. Of course, there was a change of currents in the circuits.

Lastly, it is said that the electricity which enters the ground is diffused. This is like lifting water on one shore of a lake and forcing it through a pipe to the other shore, where, falling into the lake, it becomes diffused all round, hardly a drop ever returning to where it was lifted. But this is not a "circuit." It may be called one, but the student whom it is so necessary to safeguard will require a special definition to fit the case.

For the reasons stated and suggested, I have long since ceased to believe that there is a circuit in the telegraphic system, whatever may be the *rôle* of the earth in that system. I may be wrong. I desire to be set right. If you will explain how the circuit is formed you will confer a favour on the present writer, and, doubtless, on many other students.

I may say here that I do not know the author, and have not read the article in *Harper's*.—Yours, &c.,

DAVID FLANERY.

Richmond, Virginia, December 22, 1881.

PNEUMATIC CLOCKS IN PARIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the last issue of your valuable journal, published the 31st December, 1881, it is stated that Mr. Mayrhofer's system of pneumatic clocks has for some time past been working in Vienna and Paris. As this is incorrect, and would be misleading, I beg leave to state that the system of pneumatic clocks which has been working for some time now in Vienna and Paris, and for

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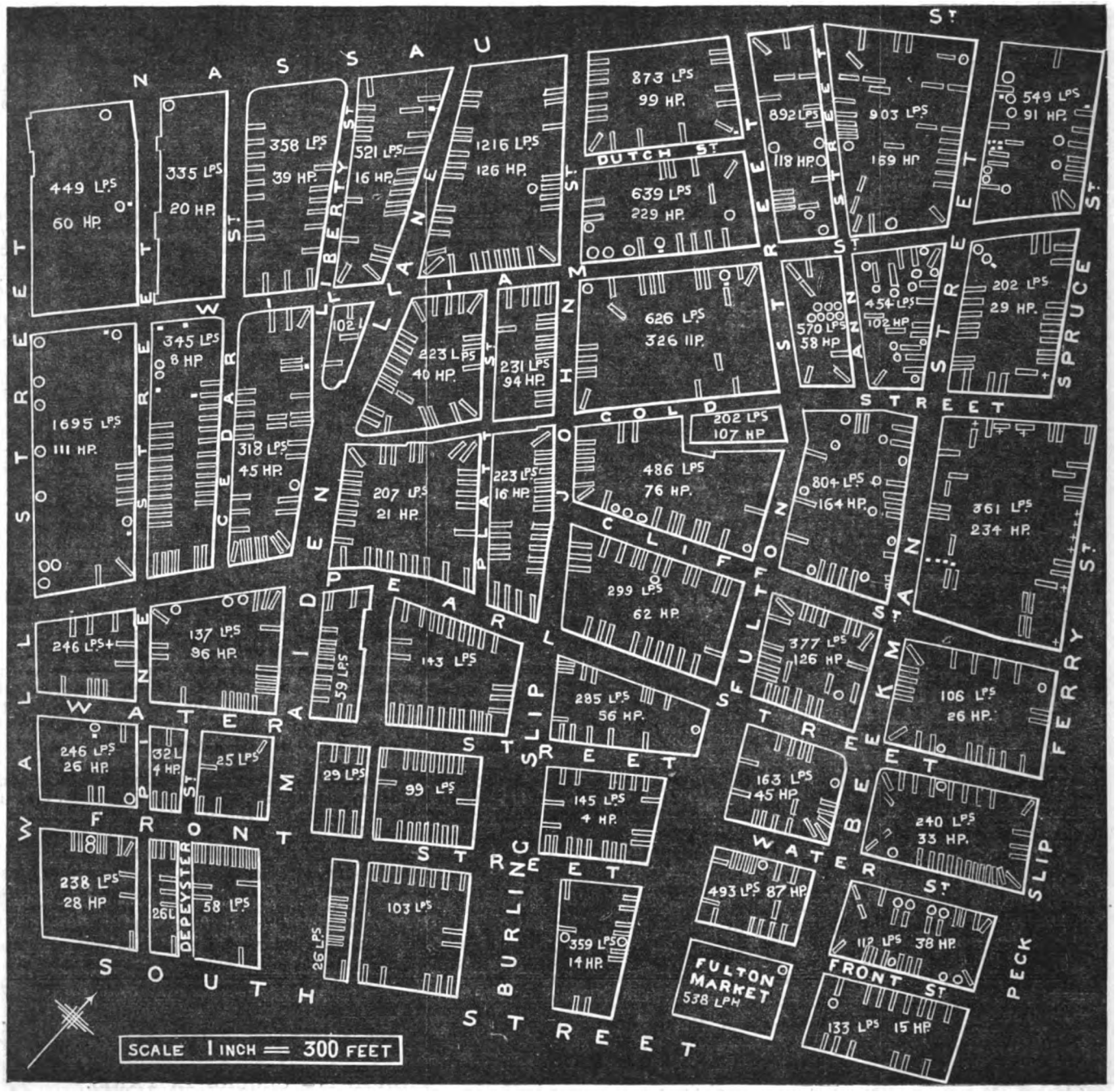
which the Compagnie Générale des Horloges Pneumatiques of Paris (the owners of all the French and foreign patents, and themselves patentees) have recently obtained a concession for fifty years from the municipality of Paris, is the Popp and Resch system, as worked by the above-mentioned company. I will thank you to insert this letter in your next issue, and beg to subscribe myself.—Yours, &c.,

J. A. BERLY.

16, New Bridge-street, London, E.C.,
January 3, 1882.

THE INSTALLATION OF THE EDISON LIGHT IN NEW YORK.



DISTRICT LIGHTED IN NEW YORK BY MR. EDISON.

Herewith we give a plan of the part of New York to be lighted by Mr. Edison. The numbers represent the number of lamps wired in each block, and the horse-power to be transmitted to work hoists, lifts, &c. This is but the first of a series of illustrations we intend to give to show the details of the whole installation.

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ELECTRIC LIGHTING.

The Economy of Electric Lighting by Incandescence.

By John W. Howell, Student at the Stevens Institute of Technology.

In carrying out this investigation I have endeavoured to determine as nearly as I was able the cost of electric lighting by incandescence. Owing to the interest attached to the subject and the lack of data upon which calculations can be based, I have endeavoured to consider the subject in all its details and have taken every precaution that suggested itself to guard against error.

The data given are sufficient to calculate the number of lamps to be obtained from each indicated horse-power in a steam engine; beyond this I have not attempted to go, as my experience is insufficient to enable me to make any further determinations.

Efficiency of the Generator.—The generator tested was one of the latest patterns devised by Mr. Edison. It differs from the generators heretofore in general use principally in the substitution of bars of copper for wires in the armature, which makes the resistance of the armature very low and also economises space, as the bars have a trapezoidal action, and when in position there is only clearance enough to allow for the insulation between them.

In my experiments the field was excited by a current shunted from the main circuit, the relative resistances of the mains and magnet coils determining the amount of energy expended on the magnets and consequent intensity of the magnetisation and the electromotive force of the generator.

Apparatus for Measurement of the Mechanical Energy transmitted to the Generator.—In measuring the energy transmitted to the generator the dynamometer built by the class of '79 was used; this was carefully standardised by supporting the pendulum in a horizontal position at a point 2ft. from the axis of the shaft, and weighing the pressure of the support upon a platform scale; the weight of the pendulum and support was 183·25, the weight of the support was 12, the weight of the pendulum was 171·2lb.

This gives us the force acting at the circumference of a pulley of 1ft. radius by multiplying 171·2 by the sine of the angle of deflection. This is a measure of the force transmitted through the gear at the top of the pendulum, and includes, beside the force required to turn the armature in the field of force, the force necessary to overcome the friction of the dynamometer bearing and also the friction of the armature shaft in its bearings. In order to determine what part of the transmitted energy was lost in overcoming friction a Prony brake was applied to the pulley of the armature.

Removing the brushes to be sure no current was generated, we tightened the brake until the pendulum showed the same deflection that it did during the test; we thus made a direct substitution of the Prony brake for the retarding action of the lines of magnetic force upon the armature when the circuit was closed, and the force exerted by the arm of the brake upon a platform scale reduced to the radius of the pulley will be the force required to turn the armature in the field of force. Instead of measuring the force exerted by one arm of the brake upon a scale, we measured the lifting effort exerted by the other end upon a weight resting upon the scale. We placed a light counter-weight upon the other end of brake to make the zero reading more definite, and in getting the zero we raised the counterweighted end and let it down gently, rapping the centre of the brake to prevent sticking.

Several readings fixed the zero between 35½ and 35. Running at about the same speed as in the test and tightening the brake until we got a deflection of 42deg., we made several readings on the scale which varied from 19 to 20½. Using the highest zero reading and the lowest running reading we got a force of 16½lb. acting at a distance of 2ft. from the centre of the shaft; this, reduced to the radius of the armature gives $16\frac{1}{2} \times \frac{24}{5} = 79{\cdot}2$, for the force acting at the circumference of the armature pulley.

If no friction had intervened this force would have been

$$\frac{171{\cdot}2 \times (\sin. 42\text{deg.} = {\cdot}66913)}{1{\cdot}25} = 91{\cdot}644\text{lb.}$$

showing a loss of $91{\cdot}644 - 79{\cdot}2 = 12{\cdot}444$lb., or 13½ per cent. of the power transmitted.

This loss of 13½ per cent. is caused by the friction of the dynamometer and the friction of the armature bearings. To get the force actually applied at the circumference of the pulley on the armature shaft we must determine the friction of the dynamometer bearing alone. To do this we made a wooden brake of the same diameter as the driving pulley on the dynamometer that could run on a 10in. pulley on the dynamometer shaft, we then clamped the Prony brake upon the dynamo pulley, and also clamped the belt on the dynamo pulley and passed it over the wooden brake. Running under these conditions and tightening the wooden brake on the 10in. pulley until the pendulum showed a deflection of 42deg., we measured the force acting at the circumference of the dynamo pulley, and also at the circumference of the dynamometer pulley by the lifting effort of the Prony brake upon the weight on the scale. The object of this arrangement of brakes was to get the friction under the same conditions as those under which we ran the test. To get the zero reading in this case we clamped the Prony on the dynamo pulley and loosened the wooden brake, and counterweighted the other arm of the Prony brake until the armature turned in its bearings; then letting it come to rest and rapping the bearings of the dynamo and dynamometer we determined the zero reading to be 33lb.

Several readings fixed the readings for 42deg. at 16lb., therefore the force acting at the circumference of the dynamo pulley was $(33-16) \times \frac{24}{5} = 81{\cdot}6$, showing a loss of $91{\cdot}644 - 81{\cdot}6 =$ 10·044lb., or 10·9 per cent. of the total energy transmitted.

Apparatus for the Measurement of Electrical Energy.—The resistance over which the generator worked consisted of three strands of iron wire in multiple arc, each of which was 104in. in diameter. These were stretched from one gallery of the shop to the other in the open air.

In measuring the resistance of the different parts of the circuit, wires were led from the binding posts of the generator to the Wheatstone bridge, then by breaking the connection with the armature and magnet coils we could measure the resistance of the line, or by breaking the connections with the line and magnets we could measure the resistance of the armature and leaders, or by breaking the connections with the armature and the line we could measure the resistance of the magnet coils.

The electrical energy developed in the circuit was determined by three methods.

1. By a voltameter, or a copper depositing cell.
2. By a calorimeter.
3. By measuring the electromotive force and resistance.

First Method.—The voltameter consisted of a glass jar, large enough to hold six plates of copper 7in. by 8in. These were placed ½in. apart, and held in place by a light wooden frame. They were connected alternately to the positive and negative wires from the generator. This method of arranging the plates brings both sides into action, gives a large area of plate, and makes the resistance of the cell very low, and the consequent heating very little. By means of mercury connections the voltameter could be thrown into or out of circuit instantly, without breaking the current, and the leaders were so proportioned that throwing it in and out did not alter the resistance of the circuit. In calculating the current from the weight of copper carried from one set of plates to the other, the weight gained by the negative plates was considered as the weight carried over, and the constant ·32456 given by Sprague (Jenkin gives ·324) for the amount of copper in milligrammes carried over in one second by a current of one weber. Before making the test the current was passed through the voltameter for some time in a direction opposite to that in which it was passed during the test, to insure that the copper carried over during the test was copper that had been deposited before, otherwise energy may be lost in separating the copper from the positive plate.

Second Method.—In determining the electrical energy by the second method a calorimeter was used which consisted of a cylindrical vessel of galvanised iron encased in a wooden jacket, and so supported as to leave an air space of about ½in. on all sides between the calorimeter and the jacket. This prevented any great conduction of heat from the calorimeter to external objects. Still some heat must be wasted in heating the calorimeter, and the surfaces it rests upon. To determine the amount of heat thus wasted, 55lb. of water was put in the calorimeter, and its temperature carefully determined—it was 19·85deg. Cent. A large pail of water was then heated to 54·7deg. Cent., and 18¾lb. were poured into the calorimeter. This made the weight of water in the calorimeter about the same as was used in the test, and the same part of the calorimeter was heated in each case;

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the final temperature of the water being 28·50deg. Cent., the range of temperature used in the test was included in this range. The heat contained in the water poured into the calorimeter may be represented by 18·75 × 26·2 = 491·25. Of this 55 × 8·65 = 475·75 went to raise the temperature of the water in the calorimeter, and the remainder 15·5 must have been imparted to the calorimeter. As the range of temperature in the calorimeter was 8·65deg., 1·78 of these units were required to raise the temperature of the calorimeter 1deg., or the same amount of heat was used in heating the calorimeter as would be required to raise 1·781b. of water through the same range of temperature, therefore the proper correction may be applied by adding 1·781b. of water to the weight of water in the calorimeter.

To measure the heating effect of the current, a coil of copper wire was put into the calorimeter, the resistance of which was exactly ·1 ohm at 74deg. Fahr. The chief source of error in a calorimeter test of this kind is the tendency of the current to pass from one part of the wire to another through the water, instead of passing through the wire. This in itself is not a source of error if we measure the resistance of the coil in the water, but in so passing it may carry metal from one part of the wire to another, and the energy so used cannot be calculated and is lost. To obviate this difficulty distilled water was used, the resistance of which is much higher than ordinary water. The resistance of the coil measured in the water did not differ perceptibly from its resistance in the air, and at the close of the test no evidence of metal having been carried from one part to the other was discernible. To determine the range of temperature during the test, a Farhenheit thermometer was used that was graduated to fifths of degrees, but the graduation was so plain that twentieths of a degree could easily be read. In order to be certain that the temperature of the water was uniform throughout, a pump was placed in the centre of the calorimeter, which consisted simply of a copper tube about 1¼in. in diameter; its bottom was ½in. above the bottom of the calorimeter, and contained a valve opening downward. The piston also carried a valve opening downward. The water in the calorimeter covered the top of the tube, and by this means the water was taken from the surface where it is warmest and carried to the bottom where it is coldest. The circulation thus obtained was very perfect, as shown by some ink-drops put in the pump barrel.

Third Method.—In determining the electrical energy by the third method the electromotive force was measured between the binding posts of the generator by means of a Thompson high-resistance galvanometer. As a standard of electromotive force Latimer Clark cells were used, four of which were made up new for the purpose. These agreed with each other very closely, and in using them they were connected in series, thus getting their combined effect and averaging their errors.

In using them they were allowed to charge a condenser, and the condenser was then discharged through the galvanometer. The deflection produced is an accurate measure of the current flowing through the galvanometer, and consequently of the charge held by the condenser, which depends upon the electromotive force of the terminal connected with the condenser. To connect the condenser alternately with the cells and the galvanometer a simple switch was used by which the change could be made instantly. In making the test part of the condenser of two microfarad capacity was used, and four standard cells in series. The damping magnet of the galvanometer was then adjusted until the discharge of the condenser produced a deflection of 291 divisions; as the electromotive force of the cell is 1·456 volts, and four in series were used, the deflection, coresponding to one volt, was:—

$$\frac{291}{1{\cdot}456 + 4} = 50.$$

The instrument being standardised in this way, the liability to error was very small; in use, however, $\frac{9}{10}$ of the current were shunted from the galvanometer, only allowing $\frac{1}{10}$ to pass through, thus getting five deflections to a volt.

The ends of all wires dipping into mercury were amalgamated with mercurous nitrate, which made the connections very perfect.

In measuring the resistances of the armature and of the armature and leaders, the Wheatstone bridge was used, and Thompson's reflecting galvanometer in place of the small galvanometer usually employed. The resistance of the armature mains and leaders was between ·17 and ·18 ohm; when the bridge indicated ·17 the galvanometer showed a deflection of 29·5 divisions; when it indicated ·18 the galvanometer showed an opposite deflection of 45; from this we get the resistance of the armature mains and leaders ·17395 ohm.

The main alone measured ·14460, leaving for the resistance of the armature and leaders to the binding posts, ·029 ohm.

Leading wires being clamped on the commutator the resistance measured in several positions was ·16207, these leaders measured ·14604, leaving for the resistance of the armature alone ·016 ohm. The resistance of the field magnet coils was 37 ohms.

(TO BE CONTINUED.)

ELECTRIC LIGHTING BY WATER-POWER.*

By Thomas B. Grierson, Assoc.I.C.E.I.

(*Continued from page* 107.)

Gas Lighting versus Electric Lighting.—That a good deal could be said in favour of both gas lighting and electric lighting there can be no doubt, and accordingly we find the gas companies telling us that not only does gas light a room but also that it warms it in winter, while the electric light evolves no heat—hence a saving in fuel; also that gas is much more dependable in its use than electricity, which latter, they say, might be extinguished at any moment by the breaking down of the machinery, which would not be the case with gas. On the other hand, those in favour of electricity say that if gas heats a room in winter it also heats it in summer, which is objectionable; and, further, that the products of combustion of the gas are highly injurious not only to health but also to oil paintings and gilding, from which objections the electric light would be free. A number of similar statements on both sides might be added to prolong the discussion, but suffice it to say the author believes the time to be not far distant when gas will be relegated to the position which the old oil lamps occupied shortly after the introduction of gas fifty years ago. At that time it was said by many able chemists that it would be madness to use gas in dwelling-houses, as it would lead to frightful explosions. Experiments were made to show its highly dangerous nature, and it was learnedly predicted that in any case it would be so expensive as to frustrate any efforts for its extended use. We know what the result has been, and we know also that history repeats itself, and hence we conclude that, containing, as no doubt it does, the elements of success, electricity will supersede gas in time, not only for lighting, but also for heating, and who knows for how many other purposes. Possibly it may yet, even in our own time, supersede steam and the steam engine itself. Who can say? It is sufficiently ominous that it has already been successfully adapted on the continent to the driving of railways. Indeed, to come nearer home, one of the Dublin newspapers in reporting lately a statement made by an eminent member of this institution, in reference to an electrical railway in the promotion of which he was interested, mentioned that the power was to be conveyed through the medium of the rails. It immediately occurred to the author that such an arangement might result in serious electric shocks to pedestrians, or even to horses, should they step upon them (there was no mention of insulation), not to speak of the inconvenience of renewing a rail in the event of an accident, as in such a case the current would be broken, and all traffic supended *pro tem.* upon the section in which such an accident might occur. One good feature of the scheme, however, was that turbines were to be employed for driving the dynamo-electric machines, the water-power of Powerscourt being utilised for the purpose. It was also mentioned that the line was to be divided up into lengths having a turbine and dynamo machine for working each length. Also, it was further stated that an electric railway is at present in course of construction to the Giant's Causeway.

From these and other statements which constantly appear in the newspapers, it would seem as if the public were gradually awakening to the advantages to be derived from the use of electricity for various purposes, but more especially that of illumination. Indeed, within the past few weeks the Savoy Theatre in London has been most successfully lighted with the Swan incandescent lamps before mentioned.

With reference to the economy of electric over gas lighting, we frequently hear it said that the cost of producing the electric light is very great, and requires a large amount of capital. But supposing for a moment that gas were in the position in which the electric light is now placed, and had to struggle against a popular oil lamp, and supposing further that any person were to propose the erection of such a magnificent gas works as that of the Alliance Gas Company with all its expensive plant for the introduction of gas, it is not at all improbable that he would be set down as an enthusiast and a madman.

Yet such may be said to be the position of the electric light at the present moment—the light being generated in isolated places is much in the same position as if gas were manufactured in a large number of small centres, instead of in one great centre or works. And there can be no doubt that even as the saving is great in the erecting of one large gas works, instead of several small ones, so would the saving effected be enormous if the electric potential were generated from one or two large centres, either by water power or steam power, as the case might be.

We must, therefore, in estimating the saving by using the electric light, look more to what will be done in the future than what has absolutely been done in the past, or is doing at present. Many clever men are at present engaged upon some of the difficulties which will have to be overcome before we finally dispense entirely with gas for lighting purposes, especially that more important one of storing the potential.

At present if the machinery were to break down while generating the current, the lights would of course be extinguished, and while this is at all likely to be the case, the number of those using the electric light will no doubt be comparatively few, as the majority of people cannot afford to make such costly experiments; but once this difficulty has been got over, and that the potential can be stored up for future use, even say for 24 hours only, the light would then be practically independent of the machinery. The battery of Faure is a step in this direction, but as yet it can hardly be called a commercial success. Mr. Brush it is said has succeeded, in part, in overcoming the difficulty. He is still, however, working out his idea in the expectation of ultimate success. When once this

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* Read before the Institution of Civil Engineers, Ireland, at the annual general meeting at Trinity College, Dublin, 7th December, 1881.

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"missing link" has been found, the success of the electric light will be an accomplished fact; or, like itself, when the current is once perfectly established, it will blaze forth a shining light and throw all others into shade.

With the permission of Mr. J. Chaloner Smith (hon. sec.), the engineer-in-chief, the author is enabled to lay before the institution a comparative statement of the costs of the methods by which a large covered space of one-and-a-quarter acres of the Dublin, Wicklow, and Wexford Railway is proposed to be lighted. It was first proposed to light this space with fifteen of Bray's lamps, each of 200 candles power, some of which were erected as a trial with very good results—the consumption of gas being slightly under the maker's estimate. Seeing, however, the success which attended the Brush system of electric lighting, Mr. Smith thought of adopting it, and thus effecting a further saving over the gas, and with this view obtained estimates lately from the Dublin Electric Light Company who, through their engineer, Mr. Jolin, recommended fifteen of their 2,000 candle lamps to be erected.

The following is a comparison of the two systems of lighting :—

GAS.

	£	s.	d.
CAPITAL ACCOUNT—			
To 15 Bray's patent, 200-candle lamps, at £12 1s. net ..	180	15	0
,, Gas mains and fittings fixed in place	150	0	0
	£330	15	0
MAINTENANCE ACCOUNT—			
To interest on capital and depreciation on £330 15s., at say 12 per cent.	39	13	9
,, Repairs and wages	40	0	0
,, Consumption of gas = 40 cubic feet per lamp per hour; and, taking an average of eight hours per day, including mornings and evenings, for 365 days, we get 40 × 8 × 365 = 116,800 cubic feet per lamp per annum; and 116,800 × 15 lamps = 1,752,000 cubic feet consumed by the 15 lamps, under the most favourable circumstances, per annum—1,752,000 at 4s. per M.	350	8	0
Total cost of Gas.....	£430	1	9

ELECTRICITY.

CAPITAL ACCOUNT.	£	s.	d.
To one No. 7A dynamo-electric machine.....	400	0	0
,, 15 electric lamps, 2,000 candle-power, each at £13	195	0	0
,, gas engine of 16 h.-p. nominal, fixed in place	360	0	0
,, Wires and small fittings for lamps.....	50	0	0
	£1,005	0	0
MAINTENANCE ACCOUNT.			
To interest on capital and depreciation, £1,005 at 12 per cent.	120	0	0
,, Wages	40	0	0
,, Carbons	6	0	0
,, Oil, waste, and repairs	15	0	0
,, Gas consumed by engine, at 24 cubic feet per horse-power per hour, working eight hours a day, for 365 days = 365 × 8 × 24 × 16 horse-power = 1,121,280 cubic feet; and 1,121,280 feet at 4s. per M.	224	5	0
	£405	17	0

The comparison of gas with electricity in this case results in a saving of about 5½ per cent. in favour of the latter; but we have also to recollect that the light from the electric lamps is exactly ten times as great as that from the gas, and hence a very considerably better light at less cost—and this under what may be called unfavourable circumstances—for being in a position where neither water nor steam was at hand, the cheapest motor under the circumstances was the gas engine. The item of gas for this engine has been taken at the maximum, but in reality the larger gas engines when working up to their full power do not consume more than about 18 cubic feet of gas per i. h.-p. per hour, or 25 per cent. less than 24, as calculated upon. If, however, a reduction is made in the price of gas (which is not improbable), if gas is to compete with electricity, when the latter is generated in and supplied from large centres, there would be a further economy in using gas engines. Water, however, would be cheaper than any of the other motive powers, wherever it was available; and in this case a turbine, with a fall of 8 or 10 feet, could be had to do the same work as the gas engine for £100, as against £360 for the gas engine, or £280 for a steam engine and boiler.

Of course in the case of taking the power from a canal to drive a turbine a small charge would have to be paid for the water, and many of the railway stations in Dublin, which have canals close at hand, could make use of this power at a cost which would be considerably less than either gas or steam, especially in maintenance.

In conclusion, referring to the respective merits of gas and electricity, it may be said of gas that it has a formidable rival in the electric light, but it may also be said with equal truth, at present at all events, electricity has an equally formidable rival in gas. And the author believes that if gas were reduced in price to two shillings per thousand that the electric light would be thrown back for some years, especially for domestic purposes, until the difficulties of storing the electricity have been overcome and a cheaper lamp invented than those at present in the market."

As to the lighting of streets and large areas, the author is of opinion that, even with the present imperfect electrical appliances and powerful lamps, electricity will gradually supersede gas, becoming more economical as its use is extended as well as developing into a more perfect system.

As for gas, there is sure to be a wide field opened up for its use, and it will probably be found that, instead of being antagonistic to one another, gas and electricity will work together amicably, each in a separate sphere of usefulness, the only rivalry between them being to see which can best supply the wants and increase the happiness of those members of the human family for whom they may be called upon to cater.

SUBMARINE CABLES.

The following letter has been addressed to Mr. Pender, M.P., by direction of the President of the Board of Trade, on the subject of the memorial presented by the telegraph companies to Lord Granville about a fortnight ago :—

"Board of Trade (Harbour Department), Whitehall-
" gardens, S.W., 30th December, 1881.

"SIR: I am directed by the Board of Trade to acknowledge the receipt of your letter of the 19th instant, addressed to the President, enclosing a printed copy of a letter which has been recently addressed to the Secretary of State for Foreign Affairs by the representatives of all the principal submarine telegraph companies, on the subject of injuries caused to submarine telegraph cables by fishing and other vessels, and of the impediments placed in the way of repairing such cables through accidental or wilful removal or destruction of the gear used by the repairing ships or otherwise, and you commend the matters treated therein to the serious consideration of this Department.

"The attention of the Board of Trade was called to this subject in October last, during the sittings of the recent International Fishery Conference at the Hague, by a letter from the Post Office to the Foreign Office, enclosing one from the Great Northern Telegraph Company and one from the Submarine Telegraph Company.

"These letters were at once referred to the British delegates in Holland, where it appeared that the subject had already been raised in the Conference by the representatives of the Danish and German Governments.

"The Conference, after considerable discussion, in which the importance of the question was fully admitted, decided that it was inexpedient to introduce any clause on the subject into the proposed Convention concerning fishing vessels. In doing this they were actuated partly by the difficulties of the subject further mentioned below, but principally because the injuries and difficulties complained of by the telegraph companies related chiefly to vessels other than fishing vessels, and because to introduce a new and foreign subject into the Convention would have endangered or delayed the attainment of its original object, which was to keep the peace amongst fishing vessels of different nations.

"The decision of the Conference was communicated by the Board of Trade to the Foreign Office on the 1st November.

"Subsequently, on the 15th November, the Board of Trade received a letter from the General Post Office, enclosing letters from the Telegraph Companies concerned in the Norderney Cable to Germany, in which the Indo-European Telegraph Company suggested that a revenue cutter should be employed to clear away the fishing vessels from the neighbourhood of the repairing ship. To this the Board of Trade replied, as the fact was, that they had no power to render assistance in the matter.

"Various complaints appeared in the newspapers, and on the 12th December the Board of Trade received a letter from the managing director of the Telegraph and Maintenance Company, giving an account of the difficulties caused to the company by fishing vessels whilst endeavouring to repair the German Union Telegraph Company's cable between Lowestoft and Greetsiel, and also of the injuries caused to telegraph cables by ships' anchors.

"In this letter, as well as in previous communications received by the Board of Trade, attention was also called to the difficulties caused to ships laying telegraph cables by the existing signals for vessels not under way, which frequently led passing ships to approach vessels laying telegraphs, thinking them in distress, whereby the gear of such vessels was interfered with.

"Finally, on December 12th, a memorial was presented to the Foreign Office by all the telegraph companies, embodying all their grievances, and a copy of this memorial was, on the 21st December, received by the president from you asking for an interview.

"The grievances complained of are as follow :—

"1. That submarine cables in shallow waters are broken or damaged by the anchors of vessels of all kinds, and by the trawls of fishing vessels; and when a cable is brought up by an anchor it is often wantonly cut.

"2. That cable-laying ships are wantonly interfered with by fishing vessels, and their nets and their buoys unshackled or destroyed.

"3. That the personal communication with the shore necessary during the repair of cables is interfered with by quarantine regulations.

"4. That cable-repairing steamers are subject to stringent and unnecessary Custom House regulations, and to light and harbour dues.

"5. That the signals approved by the Admiralty and the Board of Trade for vessels not under way, and which consequently must be adopted by telegraph-laying vessels, are such as to lead passing ships to approach them for the purpose of rendering assistance.

"There is one observation which applies to all these causes of complaint, and which in itself affords a reason why neither the Board of Trade, nor any other Department of Her Majesty's Government, or even the British Legislature, can, even if so disposed, afford immediate relief. This is, that in every one of the cases of complaint mentioned in the memorial foreign nations are concerned as well as ourselves, and we can only proceed with their concurrence. This is, of course, no reason why Her Majesty's Government should not take the initiative where they see their way clearly; but it makes it imperative on them so to do before they make communications to foreign Governments.

"Taking the several points in succession, the following appear to the Board of Trade to be considerations which must be borne in mind, and which show that the suggestions of the companies require more consideration than they have yet received :—

"(1.) As to the injury done to cables by anchors and by trawls.

"Upon this it is to be observed that, *primâ facie*, the sea is free to all vessels, and that before the general rights of navigation or free fishing are restricted, not only some good cause must be shown, but some feasible mode of restriction suggested. As regards anchoring, it is a question not only of convenience, but of safety, and considering the number of telegraph cables, the different courses and directions which they take, and the impossibility of marking them or denoting their locality to passing ships, it would be as unjust as it would be impracticable to deny to passing ships the rights of anchorage which they have always enjoyed.

"As regards trawls, it does not appear on examination that much if any damage is caused by them, unless they are improperly repaired, so as to

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leave projecting pieces of iron. Considering the impossibility of examining every trawl to see that it is in a proper condition before it is used, it does not appear practicable to legislate on this particular point. Nor does there seem to be any *primâ facie* reason why trawlers should be required to abandon their fishing grounds to cables, or why cables should not, so far as possible, be laid in parts of the sea not used by trawlers.

"Further, as regards both anchoring and trawling, it is not the interest either of ships in general or of fishing vessels to injure telegraph cables. On the contrary, they are themselves delayed and injured by the fouling of their anchors or their gear, so that it has been proposed in some of the papers before the board that the telegraph companies shall pay compensation to the vessels which have been detained by fouling a cable innocently when no damage is done to the cable.

"This same consideration makes it somewhat difficult to suggest any practicable penalty for cutting a cable which has been fouled. To cut a cable wilfully and needlessly, when with a little trouble the anchor or fouling gear might be disengaged without danger or loss, is no doubt an offence which ought to be, and probably is, punishable by damages. But if the question of the loss of an anchor is involved, and of possible danger or great inconvenience from this or other causes, courts of law would probably look leniently on the cutting of a cable, whether in a suit for damages or for a penalty. The probability of such a defence, and the difficulty of proving wilful damage, are serious obstacles to efficient legislation.

"(2.) As to interference with cable-laying operations.

"Some of the objections which have been stated above apply to this cause of complaint also, but in a minor degree. The cable-laying is temporary; the cable-laying vessels and their buoys can be distinguished, and, if they are in possession of the ground, there seems to be no reason why fishing vessels should be allowed to disturb or injure them pending their operations. There would, so far as destroying and unshackling buoys is concerned, remain the difficulties of evidence—difficulties which are much enhanced by the different nationalities of the different fishing vessels. But, subject to these difficulties, the Board of Trade see no reason why some attempt should not be made to meet the views of the telegraph companies on this point.

"It must not, however, on the other hand, be overlooked that there have been complaints by the masters of fishing boats that their nets have sustained damage through cable-laying buoys being placed on the fishing grounds without any notice, and that claims for compensation on this account have been, without success, made on at least one of the companies.

"Wilful and unnecessary damage to telegraph-laying ships and their gear is an offence which certainly ought to be prevented wherever it is practicable.

"(3.) As to interference with cable-laying by quarantine regulations.

"This is not a matter for the Board of Trade, but for the Foreign Office.

"(4.) As to Customs regulations and light and harbour dues.

"The Customs regulations here referred to appear to be those of foreign countries, and are therefore matters of which the Board of Trade have no cognisance. They would require to be dealt with in detail, and through the Foreign Office.

"As to light and harbour dues, the Board of Trade can see no reason for exempting cable-laying vessels from dues which other vessels pay. The exemption of Government vessels from these dues is questionable in principle, as is shown by the recent action of the Government and Parliament in respect of local rating. And there is certainly no reason to extend this exemption to vessels belonging to private companies which exist for purposes of profit, and which have the full advantage of the services for which the dues are levied.

"(5.) As regards the signals which cable-laying ships are required to use.

"These signals were recommended by a committee, on which the Admiralty, the Board of Trade, and the Trinity House were represented, and they have been adopted by all maritime nations. It is to be observed, with respect to them, that they are not, and were not intended to be, signals of distress, which, as authorsed by the Board of Trade, are signals of a very different character.

"That they have been construed to be, and are looked upon by passing ships as, signals of distress, is a result which was not foreseen when they were devised, and when one of the great objects in view was to avoid an unnecessary multiplication of different signals. Experience, however, seems to have shown that they are open to the objection above referred to, and the increase in the number of cable ships has increased the inconvenience. Under these circumstances the Board of Trade propose to refer this point to the above-mentioned committee, which is about to meet again.

"If, after consideration of these observations, and the preparation of definite answers and suggestions, the telegraph companies should desire a personal interview, the president will be happy to receive a deputation.—Yours, &c., (Signed) "C. CECIL TREVOR.

"J. Pender, Esq., M.P., 66, Old Broad-street."

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The report of the directors presented to the ninth ordinary general meeting, held at the Cannon-street Hotel, on Friday, the 6th instant, for the year ended 30th September, 1881. The total earnings amount to £116,391 5s. 6d., an increase of £5,458 4s. 9d., compared with last year. In addition to the ordinary revenue £1,710 18s. 4d. have been recovered in law charges, and £780 3s. 4d. in the salvage of two vessels by the ss. "Norseman," the total gross receipts being £118,882 7s. 2d., against £113,933 0s. 9d. for 1879-80. The working expenses for the year, including law charges, amount to £28,654 1s., as against £33,179 5s. 8d., a decrease of £4,525 4s. 8d. The maintenance for the year amounts to £41,807 9s. 3d., as against £41,849 2s. 3d. After paying the debenture interest and the loss incurred by the Company *re* Quintero collision, the balance remaining to the credit of the net revenue account is £18,074 12s. 2d., against £1,515 10s. 8d. for 1879-80. The continuing large expenditure on maintenance account is owing to the quantity of sheathed cable which has been inserted during the past year in the place of the deep sea type to which, where laid in shallow water, the interruptions to the Company's cables have from time to time been due. During the past year one hundred and eighty-eight knots of new main sheathed cable have been laid in substitution for a similar length of the old type. Two-and-a-half knots of shore end have also been renewed. The directors feel that until the remainder of the unsheathed cable in shallow water is thus replaced the Company's system will be more or less subject to interruptions. The attention of the shareholders has been, from time to time, directed to the extreme importance of maintaining the lines of the Company in an effective state. The provision of a type of cable proved to be reliable and suitable for the purpose is the only mode of preserving the system in good working order. The directors have consequently contracted with the Telegraph Construction and Maintenance Company for a further length of 400 miles, which they propose to insert as opportunity offers. The Board confirm the circular of 4th November, 1881, relative to the compromise effected of the action recently instituted by the Company. On this account, up to the 30th September last, £10,480 had been received in cash, and £3,800 nominal in shares, and since that date £96,851 16s. in cash and £37,200 nominal in shares. A sum of £21,024 cash still remains outstanding, but is amply secured. The manner in which these amounts should be dealt with hereafter depends upon important considerations not yet sufficiently developed to enable the directors to make a definite recommendation. Since the last meeting the secretary of the Company has again proceeded to Brazil, with the object of arriving at an arrangement with respect to the competition of the land lines. The shareholders were informed at the last annual meeting that the Company had arranged for a survey of the Central American Company's line. The result of this survey, embodied in a report received towards the end of the past financial year, shows that it has become inadvisable to retain the Central American Company's securities upon the books of this Company as an asset. The joint owners of the Central American Company are in possession of the necessary concessions from the Brazilian Government for the resuscitation of this route, should circumstances render it desirable, and the whole subject is receiving careful consideration. The retiring directors are Messrs. Weaver and Earle, who are eligible for re-election. The auditor, Mr. Weise, retires and is eligible for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Jan. 4.		Business Done Week Ending Jan. 4. Highest.		Lowest.	
Anglo-American	51,	51½	.....	51½	.....	50⅞
Do. Preferred	78½,	79½	.....	79½	.....	79
Do. Deferred	21⅝,	22⅛	.....	22⅛	.....	21⅝
Brazil Submarine	11,	11⅛	.....	11⅛	.....	11⅛
Cuba	9½,	10	.....	—	.....	—
Do. Preference	16,	17	.....	—	.....	—
Direct Spanish	4½,	5½	.....	—	.....	—
Do. Preference	14½,	15½	.....	14⅞	.....	14⅞
Direct United States Cable	10⅜,	10⅝	.....	10⅝	.....	10⅜
Eastern Telegraph	10⅛,	10⅜	.....	10⅛	.....	10⅛
Do. 6 per Cent. Preference	12⅜,	12⅝	.....	12⅝	.....	12⅜
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	11,	11⅛	.....	11⅛	.....	11⅛
German Union	10,	10½	.....	—	.....	—
Globe Telegraph and Trust Company	6⅜,	6½	.....	6⅝	.....	6½
Do. Preference	12⅛,	12⅝	.....	12⅝	.....	12⅛
Great Northern	11⅜,	12⅛	.....	12⅛	.....	12⅛
Indo-European	28,	29	.....	—	.....	—
Mediterranean Extension	2⅛,	2⅜	.....	—	.....	—
Do. Preference	9½,	10	.....	—	.....	—
Reuter's	12,	12½	.....	—	.....	—
Submarine	290,	300	.....	291½	.....	291½
West India and Panama	2,	2½	.....	2⅛	.....	2
Do. 1st Preference	7⅞,	8⅛	.....	8	.....	8
Western Brazilian	8,	8½	.....	8⅜	.....	7 15-16
West. Union 7 per Cent. 1st Mortgage	123,	128	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	104,	107	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1⅛	.....	1⅛	.....	1 7-16
Oriental	⅜,	½	.....	9-16	.....	9-16
United Telephone	12,	12½	.....	—	.....	—

ELECTRIC LIGHT.

Electric Light and Power	1⅛,	1⅜	.....	1 5-16	.....	1⅛
Anglo-American Brush	8⅞,	9⅛	.....	9⅛	.....	8⅞

TRAFFIC RECEIPTS FOR DECEMBER, 1881.

Companies.	Dec., 1881.	Dec., 1880.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	£2,500	£2,494	£6	—
Direct Spanish Telegraph Company	1,459	1,520	—	£61
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,319	28,010	3,309	—
Eastern Telegraph Company	49,844	46,776	3,068	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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SLIP

NEW CABLE.—The new cable between Trieste and Corfu was to be opened for public use this week.

ELECTRIC LIGHT FOR CROYDON.—It is stated that the electric light is to be introduced into Croydon.

THE MAGAZINES.—The January number of the *Edinburgh Review* contains an article on Electromotive Power.

POSTAL TELEGRAPH APPOINTMENT.—Mr. J. Kinnear, telegraphist at Edinburgh, has been appointed Postmaster of Kelso.

AN ELECTRICAL EXHIBITION.—It is stated that the Technical Society of St. Petersburg are organising an electrical exhibition.

THE ELECTRIC LIGHT IN THEATRES.—It is said that the electric light is shortly to be introduced into the Theatre de la Monnaie at Brussels.

PANAMA AND COLON.—Telegraphic communication between these places and Jamaica is interrupted owing to the breakage of the Jamaica and Colon cable.

NEW CABLE BETWEEN MARSEILLES AND TUNIS.—*La Lumière Electrique* says that the Government are thinking of laying a special cable between Marseilles and Tunis.

DIRECT SPANISH CABLE COMPANY.—The traffic receipts of this company for the month of December amounted to £1,459, against £1,520 in the same period of last year.

THE ELECTRIC LIGHT FOR HASTINGS.—The Town Council of Hastings have appointed a committee to report upon the desirability of introducing the electric light into that town.

DIVIDEND.—It is notified that the directors of the German Union Telegraph and Trust Company have resolved to declare an interim dividend of 5s. 9d. per share, free of income-tax.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.—The Marquis of Lorne paid a visit to this exhibition on Friday week, prior to his departure for Canada, which took place last Wednesday.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for December amounted to £31,319 against £28,010 for the same month of last year, being an increase of £3,309.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December amounted to £49,844, against £46,776 for the same period last year, being an increase of £3,068.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for December amounted to £16,720, making the total for 1881 £234,720, against £236,571 in 1880, and £207,853 in 1879.

THE EDISON LAMP AT STRASBOURG.—The new railway terminus at Strasbourg is to be lit up by Edison's incandescent lamps. They are to be fixed on the present gas brackets, &c., to the number of eighty.

TELEGRAPHIC COMMUNICATION FOR BATH.—The Town Council have addressed a letter to the Postmaster-General, urging the desirability of providing increased facilities for telegraphic communication in that city.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended December 31, 1881, are £2,389, as compared with £1,913 in the corresponding period of 1880.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting of this society takes place on the 19th inst., when an inaugural address will be read by the president elect, Lieut.-Colonel C. E. Webber, R.E.

THE LATE PROFESSOR CLERK MAXWELL.—Messrs. Macmillan are shortly to publish a life of the late Professor Clerk Maxwell, by Professor Campbell and Mr. William Garnett. The book is to contain a number of illustrations.

ELECTRIC LIGHTING IN FRANCE.—Amongst the series of measures for public undertakings to be introduced into the Chamber of Deputies during the approaching session is one to provide for the lighting of the French coast by means of electricity.

CUBA SUBMARINE TELEGRAPH COMPANY.—The twenty-first ordinary general meeting of this company is to be held at the offices, 61, Old Broad-street, E.C., on the 18th instant, at one p.m. The report of the directors will be found on another page.

ACCIDENT BY LIGHTNING IN EGYPT.—News from Alexandria says that during a storm at Damanhour, a large town between Alexandria and Cairo, the lighting struck the minaret of the Mosque, which it destroyed, and killed a number of the people.

WHY ELECTRICIANS USE GAS IN THEIR OFFICES.—The correspondent of a provincial paper says that the reason why Mr. Swan, of Newcastle, uses gas in his factory is because the electric light is "the light of the future," and that Mr. Swan evidently knows this.

TELEGRAPHIC COMMUNICATION WITH TOBAGO (WEST INDIES).—It is stated that a petition to the Assembly has been drawn up at Tobago, praying that telegraphic communication may be established therewith. The petition has received numerous signatures.

ELECTRIC LIGHT FOR THE HOUSE OF COMMONS.—It is stated that the electric light will not again be introduced into the House of Commons during the ensuing Session, or, at all events, not during the early part of it, but Palace Yard will be lighted by electricity as usual.

THE TELEPHONE AT WALSALL.—At a recent meeting of the Walsall Town Council it was decided to accept the offer of the National Telephone Company to erect and maintain a telephone wire between the old and new gas works and the town clerk's office, for £30 per annum.

ELECTRIC LIGHT FOR RIPON (YORKS.).—At a recent meeting of the town council a scheme was brought forward for purchasing a water mill, and utilising the power to generate electricity for supplying electric lights to the town. The matter was referred to a committee.

TELEGRAPH TARIFFS IN BELGIUM.—The tariff for ordinary telegrams in Belgium has lately been modified as follows:—For 15 words 50 centimes, and for every five words, from 15 to 50, an additional 10 centimes; above 50 words the charge is 10 centimes for every additional 10 words.

ELECTRIC LIGHT IN BOSTON (U.S.A.).—The superintendent of lamps, Boston, has been instructed by the City Council to place as many electric lights in the principal thoroughfares as he shall deem proper, provided the expense shall not exceed 65 cents. per lamp per night.

NEW CABLE.—A telegram to the *Standard* of Thursday last, dated New York, Wednesday night, says:—Jay Gould's plans for a cable to Brazil *vid* the Bermudas, St. Thomas, Paramaribo, and Fortaleza are complete; the Brazilian concession has been granted, and the cable ordered.

GAS AND ELECTRICITY IN FRANCE.—A somewhat novel departure has been taken at Toulouse, in the south of France, by the Compagnie Lyonnaise des Eaux et de l'Eclairage.

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This company has bought the gasworks there, but intends to light some of the principal streets with the electric light.

Electric Light in Lafayette, U.S.A.—The Town Council of Lafayette, Ind., have accepted a proposal to place an electric light of enormously high candle-power (20,000 candles is the power named) on a school tower in the town. They are to pay 5,000 dollars for the use of the light during two years.

Electric Light in Buda-Pesth.—We learn from Vienna that a joint stock company, with a capital of 600,000 florins, of which more than the half has already been subscribed, is in course of formation in Buda-Pesth, with the view of introducing the electric light into that city.—*Liverpool Journal of Commerce.*

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending the 31st December amounted to £2,147, and for the week ending 6th January, 1882, to £2,366, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

The Telephone in Berlin.—The Opera House at Berlin was recently connected with the Post Office in the Leipziger Strasse by means of the Bell-Blake telephone. The transmitters were placed on the stage. The music and different voices of the actors and actresses were distinctly heard in the Leipziger Strasse.

The Electric Light in Russia.—The bay of Novorussüsk, where most of the petroleum obtained from the oil-bearing regions of South Eastern Russia is put on board ships, is to be lighted by the electric light, to enable the work to be carried on night and day. The lamps are the Crompton arc lamps.

Royal Society.—The following papers, amongst others, were to have been read before this society on Thursday last, viz.:—"On the Variation of the Electrical Resistance of Glass, with Temperature, Density, and Chemical Composition," by T. Gray; and "On a New Electrical Storage Battery (Supplementary Note)," by H. Sutton (Ballarat).

Railway Signalling.—Mr. A. W. Tuer writes to the *Daily News* under this heading, suggesting that if "passengers were made acquainted with the state of the signals as they pursued their journey (which I think could be managed by means of an automatic electric indicator fixed in each compartment) neither driver nor guard dare for an instant neglect them."

Electric Light for India.—The *Malta Standard* of 4th January, after referring to the lighting of the Theatre Royal by the Eastern Electric Light Company with Brush lamps, which we have already announced in a recent note, remarks that Mr. J. Fotheringam, the company's engineer, was to sail for India on the 6th January, where the company are about to introduce the Brush and Lane-Fox lamps.

Gas and Electric Lighting at Dundee.—At a recent meeting of the Dundee Gas Commission it was agreed, in view of the adoption of the electric light, to purchase and exhibit cooking and heating stoves, and to advertise that they were prepared to let them at a rental of 10 per cent. on the list price. The Dundee Gas Commission are setting a good example in thus preparing for future possibilities.

Electric Light at Marseilles.—M. Vernes, the engineer of Messrs. Sauter, Lemonnier, and Co., of Paris, the well-known electric light contractors, has been engaged in surveying the northern basins of Marseilles harbour, with a view to their illumination to the best advantage by means of the electric light. The object of using this light is in order to facilitate the carrying on of work by night as well as day.

Improvements in the Bunsen Cell.—It is found that the substitution of a solution of sodium or ammonium chloride for the dilute acid in a Bunsen cell is an improvement. The zinc need not be amalgamated. A solution of one part sodium sulphate in five parts water may, with equal advantage, be substituted for the dilute sulphuric acid in both Grove's and Bunsen's cells.—*Journal of Chemical Society.*

Concert by Telephone.—One of the first of the regular winter concerts was given at Ipswich a few days ago, when a gentleman, Mr. E. Packard, jun., of Bramford, took the opportunity of listening to it by means of a Gower-Bell telephone. The distance between Bramford and Ipswich is two miles. The concert was heard very distinctly as a rule, though some of the lower pitched voices, such as contralto and bass, did not sound quite as clearly as the others.

Weather Telegrams.—The benefit of a rapid intercommunication of "weather facts" is now constantly shown in the China Seas. The observatory at Manila, directed by a Jesuit priest, sends out weather telegrams, and during the last south-west monsoon, all the typhoons of those seas, to the number of nine, were accurately "advised" both as to time and direction. These telegrams are especially welcome at Hong Kong, 800 miles away, where there is as yet no observatory.—*St. James's Gazette.*

Cable Laid.—We have received information that the Goatzacoalcos Vera Cruz section, has been successfully completed. This is the first section of the Central and South American Telegraph Company's system from Vera Cruz to Lima. The work was done by the India Rubber, Gutta Percha, and Telegraph Works Company's ss. "International," Mr. Theophilus Smith, engineer in charge, assisted by Mr. J. Rippon. The company must be congratulated on receiving such good news at the commencement of the year.

Brush Electric Light Company.—The directors of this Company have decided to recommend to the proprietors a payment out of manufacturing profits of a dividend at the rate of 12½ per cent for the year ending December 31, 1881, writing off all preliminary expenses, 10 per cent. depreciation on all plant and machinery, and carrying forward a balance of £2,934 18s. 9d. to next year. They have also transferred the sum of £99,500 to a reserve fund, which has been realised by sale of patents, concessions, and licenses.

Electric Lighting at the Crystal Palace Exhibition.—Amongst the first to have their lights in working order are the Electric Light and Power Generator Company. At present they have only Weston arc lamps at work in the interior, and a Maxim search light on the roof of the Palace, but all the machines and wires are ready in place for lighting by the Maxim incandescent system when the Exhibition is opened. A feature of this exhibit is that but one small engine of 20 horse-power is used to supply the power required by the various machines.

Electric and Gas Lighting for Malta.—The committee appointed to report upon the tenders for lighting Valetta and other parts of Malta by gas or electricity have published their report, in which they recommend the acceptance of the tender of the Malta and Mediterranean Gas Company, who were the former contractors. The Gas Company have, however, been compelled to reduce their price by 2s. 4d., or 28 per cent. off the price they at present charge. Tenders for lighting by electricity were received from Messrs. Siemens Bros. and Messrs. T. Docwra and Son.

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ANOTHER GALE.—A heavy gale visited the north of England and Scotland on Thursday and Friday week, the result being great interruption of telegraphic communication in those parts. In the extreme north of Scotland and in the Orkneys the gale was accompanied by thunder and lightning. In the latter islands the lightning passed down the chimney of a farm house, striking four persons sitting round the fire, and more or less injuring all of them. A young man outside the house also received so severe a shock that he is not expected to recover. Another farm house was also struck, an ox killed, and three persons injured.

THE FUTURE.—A glimpse into the future is afforded in an extract from a speech recently delivered at a preliminary meeting in Paris of the company which has been formed to work M. Marcel Deprez's system of transmitting power by means of electricity. M. Bontoux was the speaker. He said:—"The division of electric energy is destined to effect an entire revolution in this sphere. The day will come, and sooner than is imagined, when the artisan family will see enter their dwelling, by means of a magic wire, the force which is now so costly to them, and this will be the democratization of force for the benefit of the working classes." What a Utopian Republic is here foreshadowed!

ELECTRIC LIGHTING ON THE TOWER SYSTEM.—American news says that the Brush Electric Light Company, of Cleveland are erecting three large iron masts for lighting the city by their light. One is located in the centre of the public square, and will be 250 feet high, 36 inches in diameter at the foot, tapering to eight inches at the top, and will probably have six lights of 6,000 candle-power. The other two will be located in relation to the first at equidistant points, so as to inclose a triangular space. The object of this is to illustrate the combined effect of a group of lights over a thickly built up part of the city. If this scheme is feasible they propose to illuminate the whole city in this manner.

ELECTRIC LIGHT FOR HULL.—Not long ago the Hull Corporation invited tenders for the supply of electric light to certain parts of the town. Two were received, from the Brush Company and Messrs. Siemens Brothers. That of the Brush amounted to £3,326 for plant, and £966 6s. for working for twelve months, subsequent purchase being one of the conditions. Messrs. Siemens sent two tenders—one, in which purchase was optional, amounted to £3,270 for plant, or £1,550 for hire and working; and the second, for purchase outright, amounted to £3,600 for plant, and £950 for working. The above tenders were considered by a committee, who resolved to recommend the council to accept Messrs. Siemens's first tender.

ELECTRIC LIGHT FOR CLERKENWELL.—TENDERS WANTED.—The Vestry of Clerkenwell are inviting tenders for lighting Pentonville-road, from the Angel to near King's-cross, with the electric light, from sunset to sunrise, for twelve months. The tenders are to include the provision of everything necessary (with the exception of a site for the engine and machinery, which will be provided by the vestry), and also to state the price which would be required for the plant if purchased by the vestry. Pentonville-road is about 1,050 yards long, and sixty-five feet wide, and is at present lighted by thirty-two lamps. Tenders are to be sent in, addressed to Mr. Robert Paget, vestry clerk, Vestry Hall, Clerkenwell, E.C., by ten o'clock on the 16th inst.

MAGNETIC DECLINATION AT HOBART (TASMANIA).—In a paper lately read before the Royal Society of Tasmania, Sir J. H. Lefroy gives a new determination of the magnetic declination—8° 49′ ·3 E—at Hobart, for the year 1881, which he had made on the site of the old magnetical observatory of 1840-48. He notes the observation of Tasman in 1642, that "near the coast here" (Tasmania) "the needle points due north," and comparing this with the values obtained by some modern observers since 1840, he concludes that the declination, which had been increasing up to the time of the magnetic survey made by Dr. Neumayer in 1863, is now decreasing. At Melbourne it has also been observed that the declination has been decreasing since 1865.—*Nature*.

THE ELECTRIC LIGHT AT SHEFFIELD.—Messrs. H. Bessemer and Co., of the Bessemer Steel Works, are testing the applicability of the electric light for their business. Messrs. Hammond and Co., of London and Sheffield, have fitted up in their principal fitting and hammer shops fourteen of the Brush arc lamps. These were lighted for the first time on Tuesday week, and are said to have burned very steadily. The Brush lamps are in constant use at Messrs. Davy Brothers, engineers; Messrs. C. Cammell and Co. Cyclops Steel and Iron Works; and Messrs. Steel, Tozer, and Hampton. A combination of the Siemens lamps with the Swan incandescent lights is now used with good results to illuminate a large drapery establishment in Sheffield.

THE NEW ATLANTIC CABLE.—The steamship "Faraday" was to leave the works of Messrs. Siemens Brothers at Charlton on Wednesday last with the final portion of the new Atlantic cable. It is of special kind and remarkable for its strength, the shore end weighing eighteen tons per mile and the deep-sea and intermediate sections corresponding. More than 1,100 miles have been taken on board, at the rate of fifty miles per day, and the cable when complete will be 3,000 miles in length. The "Faraday" has made three previous voyages on the same work, leaving the end of the cable on each occasion buoyed in the Atlantic, where it has endured the storms of the past year without the slightest injury. Mr. Jacob, chief electrician, and a large staff are conducting operations, and the ship is in command of Captain Maypee.

THE TELEPHONE IN PLYMOUTH.—The *Western Morning News*, of 5th January, has a short article, entitled "The Telephone Deadlock in Plymouth," in which the action of the Post Office in not allowing "a £10 exchange" to be established there is very severely criticised. The writer of the article says:—"The only reason I can assign for the action of the Postal Department is the earnest desire of the officials to show a good balance-sheet, and a morbid dread that a £10 exchange would necessitate a reduction in their telegraph charges. They seem to forget that the profit of the department may be obtained at a national loss. I venture to think that, if the nation were asked to-morrow to choose between a £500,000 surplus in the Telegraph Department of the Post Office and a threepenny telegram or telelogue, they would unhesitatingly choose the latter."

ELECTRIC SEARCH LIGHTS AT PORTSMOUTH.—The experiments which have been conducted on board H.M.S. "Sultan" at Portsmouth, to ascertain whether the electric search lights in men-of-war could be protected from the guns of torpedo boats by the adoption of reflected light under cover have been concluded. Four different kinds of lenses were tested for purposes of comparison, the intensity of the electric beam being measured by a Bunsen's photometer and one of Sugg's burners. The apparatus used were a dioptric lens, a catoptric lens 90 centimetres in diameter, the ordinary above-board ship's glass, which was similar in character, but only 60 centimetres in diameter, and a reflector made of Chance's glass and silvered. The respective merits of each were found to be in the order mentioned, the dioptric producing double the illuminating power of the next best.

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RECENT WONDERS OF ELECTRICITY.*

BY W. H. PREECE, F.R.S.

At the second of the short series of lectures adapted to juvenile audiences during the Christmas holidays given by Mr. W. H. Preece, F.R.S., the lecturer said one of the principal objects of his last lecture was to disabuse the minds of his hearers of the idea that electricity was a fluid or any tangible form of matter. It could be spoken of as a distinct entity in the same manner as heat, light, or sound, without any sensible existence being implied, but all its effects, and indeed all physical phenomena, were forms of energy. Energy was as much entitled to reality as matter. Like matter, it could neither be created nor destroyed, human power could only transform and apply some available store of it to useful purposes. Wherever a current of electricity was produced, energy was expended and work done; and energy expended at one point of a system must appear, in some form or other, at another point. In the last lecture electro-magnetism was shown as a form of energy, and, in continuance, the lecturer showed that when electricity was driven through a chemical compound in solution or liquid its action was to break up the compound into its constituent parts, and the weight of the material decomposed per minute was an exact measure of the work done or of the current passed. Water, for instance, was broken up into its elements, oxygen and hydrogen; sulphate of copper into sulphuric acid and copper, and nitrate of silver into nitric acid and silver; hence the practical application of electricity to electro-typing, electro-plating, and nickel-plating, which processes were illustrated. Some interesting experiments prepared by Mr. Bolas were shown, and each boy was presented with a silvered button electro-plated in the room. When electricity was transferred through solids the work done appeared as heat, and a definite amount of heat appeared for every unit of energy expended, and its temperature varied with the resistance of the material to the passage of electricity. Fine wire of platinum or iron was shown to become intensely heated when electricity passed through it, which explained the principle of electric fuses for blasting purposes, &c., in mines, discharging torpedoes at a distance, firing broadsides on board men of war and other practical applications. Some admirable experiments, prepared for the lecturer by Professor Abel, C.B., illustrated that branch of the subject. The work done by electricity in its passage through air and gases, the lecturer went on to say, appeared as sparks and light. Sparks were due to matter rendered incandescent by the high temperature produced. Some beautiful effects through vacuum tubes by induced currents from a large induction coil were shown, which led up to the electric light, for which greater currents of electricity were required than had yet been shown. It was necessary to call in the aid of mechanical power to produce those great currents, and for that purpose the steam engine or water power was brought into requisition. The motive force was simply the motion of a conductor through a magnetic field, and the greater the intensity of the magnetic field and the increased velocity with which the conductor cut the field at right angles to its lines of force the greater was the current. Magneto-electric machines were those in which the field was produced by permanent steel magnets; dynamo machines were those in which the field was produced by an electro-magnet excited by the current which it itself produced by a kind of accumulating action. In each case the current was the result of the mechanical work expended, and, with the exception of that portion necessarily wasted in friction, was an exact measure of the horse-power exerted. Such powerful currents were utilised in "arc" electric lamps, where rapid sparks were passed through air between two rods of carbon, which were disintegrated and rendered highly incandescent; or in "incandescent" lamps, where they passed through solid carbon filaments, which became raised to a very high temperature, and therefore gave a brilliant light. The hall was lit up by Edison incandescent lamps. It was then shown that the action of magneto or dynamo machines was reversible, and that the currents from the first machine would cause a second similar machine at a distance to be driven backwards; hence the applicability of electric currents to the driving of cars on railways, to ploughing land, to boring rocks, to printing, to sewing machines, to ventilation, to wood carving, and to various industrial and useful purposes.

* Abstract of Lecture delivered at the Society of Arts.

DYNAMO-ELECTRIC MACHINES.

Some useful information is contributed to the December number of the *Journal of the Franklin Institute* by Professor Elihu Thomson, entitled "Notes on the Properties of Dynamo-Electric Machines," from which we extract the following:—"The machines with which the experiments were made," he says, "were of my design, and consist of an armature of spherical outline revolved between two magnet poles, constituting two nearly hemispherical concavities enveloping the armature. The field coils are two in number and surround the field cores, and also the armature itself. The armature has three coils only wound upon it, and the commutator three insulated segments of a ring, the slots between the segments allowing them to overlap, so that each segment covers over 160° of the outside circle of the commutator. The machines could sustain from four to ten arc lights in series, at about 800 revolutions per minute. The first experiments illustrate the tendency of the magnets, which were of cast iron, to prolong the generated current even after stoppage of the machine. Motion of about 150 revolutions per minute was given to the machine while on close circuit, until it had charged its magnets, and had shown in consequence of a development of current a considerable resistance to rotation. It was then suddenly stopped, and immediately thereafter its circuit opened, when there appeared a small but distinct spark at the break. Other evidences of the circulation of the current were obtained immediately after the complete stoppage of rotation. A smart shock could be felt by grasping the wires on each side of the break in the circuit at the time it was made. The origin of this after-current is, of course, the gradual loss of magnetism of the field magnet cores, which induce a current in the encircling wire during the time that such magnetic charge is taking place. The duration of the current is about half a second, but increases with the size of the machines. . . . A more curious effect, however, is produced by putting the same machine upon closed circuit and then revolving it as before at a moderate speed. The motive power is now suddenly removed. The armature in this case rapidly comes to rest, and then, singularly, takes about three-quarters of a turn in the opposite direction. . . Another observation made was as follows:—A single machine driven by power was connected to two others in multiple arc, so as to drive them as motors; but these latter, although relatively nearly alike in proportion, were of different sizes—the electromotive force of one being double that of the other when driven at equal speed. When joined up to the first machine or generator, in parallel circuit, both the other machines acted as motors and revolved. The speeds which they acquired while not performing work were, however, very unequal, and were found to be approximately in the inverse ratio of their electromotive forces as generators when driven at an equal speed. It would seem from the above that both machines, working as motors without retardation other than air resistance friction, attain such speeds that the counter-electromotive forces developed by them are nearly equal, and the current traversing each of them also nearly equal. The different electrical resistances of the two machines is no doubt a modifying influence, but it seems to have little effect, and, in fact, counts for little in comparison with the counter-electromotive forces developed under the conditions. The effect of running the two machines in series as motors is very different. When so used, and with their shafts very free to turn, the larger, or one capable of producing the highest counter-electromotive force to that of the generator, alone revolves, while the smaller remains at rest. If, however, the former or larger machine be made to perform mechanical work, its running speed is, of course, retarded, and the other machine turns with a speed depending on the amount of work abstracted from its companion."

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ON THE THEORY OF DYNAMO AND MAGNETO-ELECTRIC MACHINES.

V.

Our main results last week were, first, the experimental fact that the potential energy of a circuit conveying a current is proportional to the strength of the current, and to the number of lines of force which thread the circuit taken negatively; and, second, the definition of unit strength of current implicitly contained in the statement that the potential energy of a circuit is numerically *equal* to the product of these two quantities, γN. The application we made of the above fact was to find the force urging a part of a circuit to move; because it is a mechanical truth that the force urging a portion of a system to move in any direction is always the rate at which the potential energy would decrease per unit displacement in that direction.

The reason why we are obliged to take the lines of force *negatively* is because the number of lines of force passing through the circuit in the positive direction tends, we know, to a maximum, whereas the potential energy of a system tends to a minimum.

The quantity N, then, or the number of lines of force threading the circuit in any position, is a measure of its potential energy when conveying a unit current; and for this quantity the name *potential* is very convenient. So that, if we have occasion to speak of the "potential" of a circuit or contour, we shall mean its potential energy if unit current circulated once round it. In other words, we shall mean the number of lines of force passing through it; or, what is the same thing, the average intensity of field in which it is placed multiplied by the projection of its effective area normal to the lines of force.

We have already considered several examples of a moving circuit, or rather of a circuit with a moving portion, but the subject is so important that we must take a few more, and this week we will consider the case of a circuit movable as a whole.

Behaviour of a Movable Circuit in a Uniform Magnetic Field.

Hang a loop of wire enclosing an area A in a field of intensity H, and let the normal to the plane of the loop make the angle θ with the direction of the lines of force in the field. Then the projected area of the loop is A cos. θ, and the potential of the circuit, or the number of lines of force passing through it, is H A cos. θ. Send round the loop a current of strength γ, and it has at once energy equal to $-\gamma$ H A cos. θ. If not forcibly held, it will now turn until θ is nothing, so as to make its potential energy $-\gamma$ H A (its minimum value). The moment of the couple urging it to to turn is $\gamma \frac{d N}{d \theta}$, that is, γ H A sin. θ.

Now this is precisely the couple urging a magnetic needle to turn, whose moment is γ A, and the result was stated before (Art. III.), and caused us to name γ A *the moment of the circuit*. All we have now done has been to show how the result is a consequence of the doctrine about lines of force.

Action Between a Circular Coil and a Single Pole on its Axis.

Consider another case—a circular loop with a single magnetic pole (*see* Fig.), of strength m, placed somewhere on its axis. Call the radius of the loop y, and the distance of the pole along its axis x. The slant distance $\sqrt{(x^2 + y^2)}$ we may call r, and the angle, whose sine is $\frac{y}{r}$, we will call θ. Now, how many of the pole's lines of force pass through the ring? Well, the intensity of the field at a distance r from the pole is $\frac{m}{r^2}$ (Art. II.), which is, therefore, the number of lines it sends through every unit area of the surface of a concentric sphere of radius r. But the whole area of a sphere is $4 \pi r^2$, therefore the whole number of lines of force sent out by the pole is $4 \pi r^2 . \frac{m}{r^2} = 4 \pi m$ (itself an important result). The number which it sends through the ring will be $\frac{m}{r^2}$ multiplied by the area of the portion of the sphere bounded by the ring. But this area is known in Geometry to be $2 \pi r^2 (1 - \text{cos. } \theta)$, hence the number of lines of force passing through it is $2 \pi m (1 - \text{cos. } \theta)$. This, then, is the potential of the circuit due to the pole.

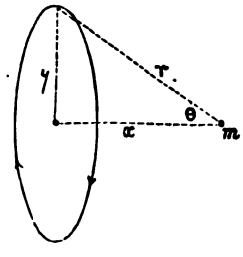
Send a current of strength γ once round the ring*, and the system has at once a potential energy $2 \pi m \gamma (1 - \text{cos. } \theta)$. Give the ring or the pole a slight displacement $d x$, and the above quantity changes by $2 \pi m \gamma$ sin. $\theta \, d \theta$, which, therefore, divided by $d x$, is the force urging the circuit to move toward (or from) the pole, or the pole to move toward (or from) the circuit.

Now, $\frac{d \theta}{d x} = \frac{\text{sin.}^2 \theta}{y} = \frac{y}{r^2}$, so the force urging the current or the pole to move is

$$\frac{2 \pi m \gamma}{y} \text{ sin.}^3 \theta, \text{ or } 2 \pi m \gamma \frac{y^2}{r^3}.$$

This force is a maximum when $\theta = 90°$, that is when the pole is at the centre of the circle, and it does not change sign when θ becomes obtuse. Hence the action of a circular current on a north magnetic pole placed on its axis so that the current as seen from the pole circulates like the hands of a watch, is to suck it in through the centre and expel it towards infinity on the other side of its plane, the force with which it acts on the pole varying inversely with the cube of the slant distance between the ring and the pole.†

We can now work out the theory of the tangent galvanometer and the measurement of current in absolute electromagnetic measure, but we will leave this till next week.



Action between a Circular Coil and a Magnet on its Axis.

Instead of a single pole, we will now put a *magnet* along the axis of a coil, treating it as simply two equal poles whose slant distances from the coil are r and r', and whose semi-subtend angles are θ and θ'. Then the resultant force on the magnet is, of course,

$$\frac{2 \pi m \gamma}{y} (\text{sin.}^3 \theta - \text{sin.}^3 \theta'),$$

and this vanishes when $\theta = \theta'$, that is when the middle of the magnet is at the centre of the coil.

This, therefore, is the position which the magnet will take up after the oscillations due to its inertia have subsided. If the current be reversed it will still be in equilibrium in this position, but in unstable equilibrium, and on the least disturbance will be driven away along the axis to infinity (provided it be not allowed to turn round; practically it turns round, and gets sucked in again).

Lines of Force Due to a Straight Row of Poles.

If a small digression may be allowed at this point, we will put any number of poles $m_1, m_2, \ldots$ all on the axis of a circular ring; the potential of the ring is

$$\Sigma \, 2 \pi m (1 - \text{cos. } \theta),$$

that is,

$$2 \pi \Sigma m - 2 \pi \Sigma (m \text{ cos. } \theta).$$

(If it is an actual case of magnets Σm must be zero.) The lines of force produced by the poles are all symmetrical about the axis, and a line of force passes through every point of the ring; and if the ring is moved about and stretched or con-

* If, instead of a simple ring, it is a coil of wire, round which the current circulates n times, all the following expressions have simply to be multiplied by n.

† By paying attention to signs, the direction of the effect can always be made out, but it is a little troublesome, and for simplicity we leave the signs out in most cases, because the direction can always be made out when wanted by Ampère's or any other mnemonic rule.

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tracted so that every point of it be made to describe a line of force, the number passing through the ring must remain constant, since lines of force never cut. The equation, therefore, to a line of force in this case of any number of poles along one straight line is, in any plane section through the axis, $\Sigma (m \cos. \theta) = \text{const.}$

It is not to be supposed for an instant that this equation applies to the case of poles scattered about space, or even about a plane; nothing so simple can be given for the general case.

The important case of a simple magnet, or two equal opposite poles, may be specially noted, namely that

$$\cos. \theta - \cos. \theta' = \text{const.}$$

gives its line of force.

Generalised Statements.

The quantity $2\pi (1 - \cos. \theta)$, or the area of a circular portion of a unit sphere, is the same thing as the solid angle subtended by that portion at its centre, and the propositions will bear generalisation, as thus:—The number of lines force of pole of strength m which pass through any contour whatever is $m\omega$, where ω is the solid angle which the contour subtends at the pole.

And for any number of poles it is simply $\Sigma m\omega$. This expression $\gamma \Sigma m\omega$ measures, then, the potential energy of a circuit conveying a current in the most general case.

Or, again, we may say that $m\gamma\omega$ is the potential energy of the pole due to a current γ circulating in the contour, or $m\Sigma(\gamma\omega)$ its potential due to a number of circuits. Now, the potential energy of a pole of unit strength is called the magnetic potential of the point where it is; so the potential of a circuit at any point is simply $\gamma\omega$, *i.e.*, is proportional to the solid angle it subtends at the point; and of a number of circuits of any shape whatever the potential is $\Sigma\gamma\omega$.

If a point moves about so that the solid angle, or sum of solid angles, is constant, it traces out, therefore, a magnetic equipotential surface, and no force urges it so to move. All the force acts at right angles to the equipotential surface.

TEMPERATURE SCALE FOR INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is well known that the efficiency of an incandescent lamp depends solely on the temperature at which it can safely be worked, or, say, the temperature at which it will last for six months. We have, however, no means of measuring that temperature in ordinary degrees, nor would such a measurement be of much use to us. May I venture to suggest through your columns that the temperatures of filaments should be expressed in terms of the h.-p. expended in lamp per square inch of filament surface.

Mr. Lane-Fox's lamps, on which I have lately been making some experiments, are constructed to work at a temperature of exactly one h.-p. per square inch of radiating surface, and at this temperature we obtain 150 candles per h.-p.; for instance, his 15 candle-lamp has a hot resistance of 45 ohms, takes 1·3 ampères to work it, and has 1-10th square inch of surface.—Yours, &c., J. E. H. GORDON.

Jan. 8, 1882.

"THE ELECTRICIAN" SUPPLEMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice with pleasure the issue of a supplement with the last edition of *The Electrician*. The information it contains I consider very interesting, and extremely useful to those engaged in the promotion of electric lighting. There is a considerable absence of data of the kind you propose to furnish from time to time, and your supplement cannot fail to be regarded as a ready book of reference. Having gone practically into the subject of electric lighting recently to a small extent, I was somewhat disappointed at the results obtained, which were owing in a great measure to the difficulty experienced in procuring reliable information, and I hope your supplement may be the means of inducing inventors to come forward and give some practical particulars which can be relied on as a basis for electrical operations.—Yours, &c., J. ANGELO FAHIE.

British and Foreign Patent Office, 2, Nassau-street, Dublin, January 10, 1882.

EFFICIENCY OF INCANDESCENT LAMPS.—We are compelled to leave over a letter from Mr. Andrew Jamieson on this subject to our next issue.

THE (ELECTRIC) CONDUCTIVE AND INDUCTIVE CIRCUITS GEOMETRICALLY ILLUSTRATED.

BY F. C. WEBB, M.I.C.E.

PREFACE.

I have long felt that there is no better or shorter method of imparting to students a correct idea of the laws of the voltaic circuit than by geometrical illustrations when possible, and indeed my little work on electrical accumulation and conduction (published in *The Electrician* (old series), and reprinted in 1862), was intended originally to have consisted principally of the conductive circuit amply illustrated by geometry, but the problems of electro-statics extended to a great length, and professional work taking me abroad, the part on conduction, &c. was never reached in the manner I originally intended.

In *The Electrician* (old series) of June 5 and 12, 1863, I, however, gave a short article under the title of "Method of Representing Geometrically the Tensions throughout a Voltaic Circuit," and in some numbers of the *Electrical Review*, some five years ago I, jointly with Mr. Kempe, gave some more geometrical illustrations of problems relating to charges in submarine cables.

It is my intention if possible now to make a more complete treatment of the subject, but in doing so I shall have, no doubt, to repeat a good deal of parts of the articles to which I have already alluded. As, however, volume IV. of *The Electrician* (old series), which contained the first of these articles, has been long since out of print, and is so scarce that the library of the Society of Telegraph Engineers does not contain any copy of *The Electrician* (old series), there seems no great harm in a little repetition.*

The work, such as it is, is not offered as any novelty, or for the use of any but those who are mere students of the elementary laws of the galvanic circuit as propounded by Ohm, with the light that more modern workers have thrown on the subject.

F. C. WEBB.

It is first necessary, in order to be able to treat of the electric circuit geometrically, to enter on a short sketch of Ohm's law, sufficient to explain the general laws of the voltaic circuit, both as regards what Ohm terms "the magnitude of the current" or, in fact, a quantity of electricity passing any particular section of the circuit in a given time," and what is now simply "the *current*," and, again, what Ohm terms "the electroscopic force," which is, in fact, the *potential* at different parts of the circuit. This will allow us afterwards to illustrate geometrically various problems relating to the electrical state of the circuit and the current flowing in it and the state of the charge in it.

Ohm starts with three fundamental positions, the first of which he thus expresses:—"With regard to the first law I have started from the supposition that the communication of the electricity from one particle takes place directly only to the one next to it, so that no immediate transition from that particle to any other situated at a greater distance occurs. The magnitude of the transition between two adjacent particles, under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of the electric forces existing in the two particles; just as, in the theory of heat, the transition of caloric between two particles is regarded as proportional to the difference of their temperatures."

The second relates to the dispersion of the electricity, and is thus stated by Ohm:—"With respect to the dispersion of electricity in the atmosphere I have retained the law deduced from experiments by Coulomb, according to which the loss of electricity, in a body surrounded by air, in a given time, is in propor-

* Through the courtesy of Mr. L. Clark, who kindly lent me Vol. IV. of *The Electrician* (old series), which forms part of his most valuable electrical library.

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tion to the force of the electricity, and to a coefficient dependent on the nature of the atmosphere."

As, however, the dispersion by the atmosphere is inappreciable in galvanic circuits generally, this law seldom comes into consideration.

The third law is thus expressed:—"The mode in which electricity makes its appearance at the place of contact between two different bodies, or the electrical tension of these bodies, I have thus expressed:—When dissimilar bodies touch one another they constantly maintain at the point of contact the same difference between their electroscopic forces."

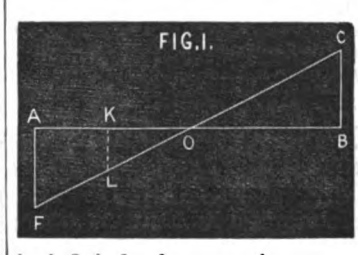
That is to say, that at any surface of generation—such as, for instance, the surface of junction between the zinc and dilute acid in a voltaic battery—the *difference* between the potentials of two points situated at an infinitely small distance on opposite sides of that surface remains constantly the same, although the potential of these points may both be increased or both decreased by an alteration in the conditions of the circuit; and notwithstanding that the difference between the potentials of two points situated further from the surface of junction, but on opposite sides of that surface, may be greatly altered by the alterations which are made in the circuit. This difference between the "electroscopic forces" or potential at the surface of junction, constituting what Ohm terms "the tension there prevailing," is, in fact, in modern language, the "electromotive force," and is a quantity dependent on the nature of the metals or liquids producing the electrical excitation, and is not variable by any alteration in the other conditions of the case, such as the resistance of the circuit or the electrical state of the whole circuit.

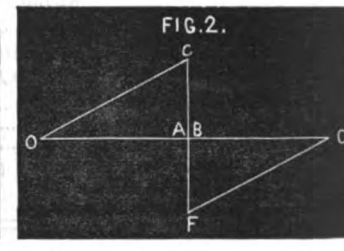
This can be made more clear when we are dealing with it geometrically. Ohm thus describes the general state of a circuit:—"By means of the first and third fundamental positions we obtain a distinct insight into the primary galvanic phenomenon in the following way:—Imagine, for instance, a ring everywhere of equal thickness, and homogenous, having at any one place in its whole thickness one and the same electrical tension,* *i.e.*, inequality in the electrical state of two surfaces situated close to each other, from which causes, when they have come into action and the equilibrium is consequently disturbed, the electricity will, in its endeavour to re-establish itself, if its mobility be solely confined to the extent of the ring, flow off on both sides. If this tension† were merely momentary, the equilibrium would very soon be re-established; but if the tension† is permanent the equilibrium can never be restored; but the electricity, by virtue of its expansive force, which is not sensibly restrained, produces in a space of time, the duration of which almost always escapes our senses, a state which comes nearest to that of equilibrium, and consists in this, that by the constant transmission of the electricity a perceptible change in the electric condition of the parts of the body through which the current passes is nowhere produced. The peculiarity of this state, also occurring frequently in the transmission of light and heat, has its foundation in this—that each particle of the body situated in the circle of action receives in each moment just so much of the transmitted electricity from the one side as it gives off to the other, and therefore constantly retains the same quantity. Now, since by reason of the first fundamental position the electrical transition only takes place directly from the one particle to the other, and is, under otherwise similar circumstances, determined according to its energy by the electrical difference of the two particles, this state must evidently indicate itself on the ring, uniformly excited in its entire thickness, and similarly constituted in all its parts, by a constant change of the electric condition, originating from the point of excitation, proceeding uniformly through the whole ring, and finally again returning to the place of excitation; whilst at this place itself a sudden spring in the electric condition constituting the tension† is, as was previously stated, constantly perceptible. In this simple separation or division of the electricity lies the key to the most varied phenomena."

I have thus far quoted from Ohm's paper as translated by Mr. Francis. I shall now attempt to explain and illustrate in my own way the general results of Ohm's paper, using the terms that I have already adopted.

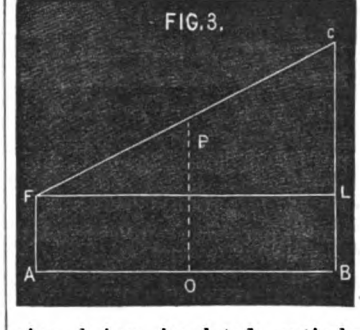
Suppose, now, the ring previously alluded to by Ohm in the quotations I have given to be opened out in a straight line, A B Fig. 1, so that A B represents the absolute length of the circuit. Let the potential at any point of the circuit be represented by the length of a perpendicular erected at that point upon the line A B. Or, more properly speaking, let the potential at any point in the circuit be expressed by the rectangular ordinate of a point above or below the horizontal line A B. When the ordinate is directed upwards, it indicates a positive potential, and when downwards a negative potential.

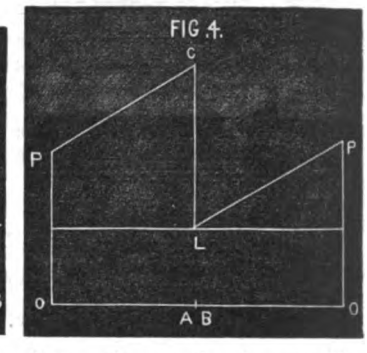
Let A F represent accordingly the potential at A, and C B the potential at B. Then, if F and C be joined by a straight line, the ordinates of this line, taken at any point along A B, will represent the potential at that point. Thus, K L will be the tension at K, and is negative; A F the tension at A, also negative; and B C the tension B, positive, the tension at O being *nil*. The line G O F may be termed the "line of potential," since it is the line whose ordinates expresses the potential at any point. It is necessary to bear in mind that, although the points A and B are supposed to be situated at opposite sides of the surface of excitation, they are deemed to



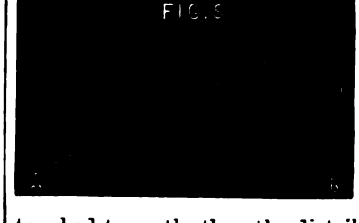


be infinitely close together, so as, in fact, to be represented by a single point, and that, if we supposed the ring opened at the point O and extended out straight, the diagram would take the form shown in Fig. 2, the line F C, showing the sudden change in potential occurring at the surface of excitation or generation, and constituting the electromotive force, or what Ohm has termed "the tension." Either of these figures would represent the electrical state of a ring having a single surface of generation at A, and not electrified by any other means than this exciting surface contained within itself at A, the two halves of the rings being supposed also in each case under precisely similar conditions as regards surrounding objects, so as to have equal electrostatic capacity per unit of length. The electricity being generated in equal and opposite quantities flows off equally on each side of the generating surface, and as the two halves of the ring are precisely similar, the neutral point, or point of recombination, or point of no potential, is situated exactly at half the length of the ring from the point of excitation. If, now, the





ring, being insulated entirely from the earth, be itself charged positively from some external source, then the potentials would be increased at every point of the circuit by a constant quantity, to be represented by raising the potential line a distance proportional to this potential of *nil* point (what was before the zero or *nil* point) and the diagram would take the form shown in Fig. 3, if opened at the point of excitation. The point A will have a potential A F, the point O a potential O P, and the point B a potential of B L + L C = B C. If the circuit be opened out at the point O midway in the circuit the lines of potential will be as shown in Fig. 4, O P will be potential at O, A C that at A, and B L that at B. Suppose, now, the ring touched the surrounding objects at some point, then it is evident that at that point there will be no potential. If the point O in Fig. 1 is touched to earth, then, since this point has already no potential, the line of tension will be unaltered, and will remain as in Fig. 1; but if any other point is touched, as, for instance, if the point A immediately on the negative side of the surface of generation is touched to earth, then the distribution of the potentials will be entirely altered, and the line of tension will assume the position A C Fig. 5. The potential at A will be zero, and at the point B it will be C B, representing the electromotive force of the circuit.



* "Tension," when employed by Ohm, implies the "electromotive force," and "electroscopic force" stands for "potential."

† Electromotive force.

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THE ELECTRICIAN.

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OUR SUPPLEMENT.

Our Supplement of last week has been reprinted, and may be had at one penny per copy.

1881.

In continuation of our brief history of electric lighting during the past year, we must, in the first place, refer again to the figures as given by the Brush Company. One of the testimonials they have received is from the Riverside Worsted Mills, which, after stating the entire satisfaction of the company, goes on to say:—"They (the lights) could not have a severer test than we give them, as our mill runs night and day the year through, and we have not had a moment's delay from, or a dollar's worth of repairs on, any of the machines or lamps. The light is all we expected; it is strong and steady, clear and white; it is universally liked both by overseers and help, so much so that we doubt if we could get along now with the help if we were to return to the old gas lighting; certainly we should not get so good work, nor so much of it. The air of the rooms, too, shows a very marked difference. In our Weave Room, with its two hundred and fifty gas lights, the air became almost unbearable after midnight in the summer; and the jaded appearance of the men showed how they felt it. With the electric light there is no such trouble, as the air is as good as in the daytime, and noticeably cooler. . . . We had formerly about two hundred and fifty gas burners of seventeen candle power each, a total of four thousand two hundred and fifty candle power. We now have twenty electric lamps of 2,000 candle-power each, a total of 40,000 candle-power. Your other question, 'How many gas burners would answer your purpose?' is more satisfactorily answered. Owing to some changes preparatory to setting up new machinery, all our eighty lamps are not at this moment in full service, but by actual count we have seventy-one lamps permanently placed, and these displace five hundred and seventy-eight gas burners: that is, there are five hundred and seventy-eight burners already placed that would be lighted were the electric lights stopped. Estimating these burners at six feet per hour, we should use 3,468 cubic feet of gas per hour, costing at 2 dols. per thousand cubic feet, 6 dols. 93 c. per hour.

The actual cost of the electric light is as follows:—

Consumption of carbons per hour	·89
Power used for machines	·65
Interest on cost of machines, say 15,000 dols....	·30
Attendance, oil, wear and tear, &c.	·36
Total cost per hour.....	Dols. 2·20

making a saving of four dollars and seventy-three cents. per hour, and this saving for the three thousand hours the machines run in the year is 14,190 dols., and nearly pays for the machines. These figures are *actual*, as we averaged the number of carbons burned for several nights. To get the exact consumption of each lamp and see the consumption of gas, we took off a number of the gas burners in use, had them tested on a test meter, and averaged them, getting a strong six feet to each burner." It should be mentioned that the Brush Company is lighting up one portion of the City of London, as well as the Charing Cross and Paddington Stations, &c.

The Brush Company has been particularly fortunate with its agents. Thus Messrs. HAMMOND and Co., who have during the past six months secured certain concessions, have been very busy. They have, amongst other installations, carried out those at several blast furnaces for the Mostyn Coal and Iron Company, Messrs. Samuelson and Co., the Airside Hematite Iron Company, and Bell Brothers; also in the steel rail mills of Bolckow, Vaughan, and Co. They have in hand installations at Moss Bay Hematite Iron and Steel Company, Workington; West Cumberland; and Steel, Tozer, and Hampton. In other branches of steel works they have fitted up Brush lights at Stanner Closes Steel Works, Wolsingham; and have in progress the work at J. Spencer and Sons, Newcastle; Henry Bessemer and Co., Sheffield, and Charles Cammell and Co., Sheffield. They have lighted engine works at Jno. Fowler and Co.'s, Leeds; Davey, Bros., and Co., Sheffield; Fawcett, Preston, and Co., Liverpool R. Hornsby and Sons, Grantham, &c. Also in the plate mills of Johnson and Reay, Stockton; Consett Iron Company; Bowesfield Iron Company, Stockton; and Gray and Gladstone, West Hartlepool. Among railway stations they have lighted up the North Eastern Railway, York; and Manchester, Sheffield, and Lincoln Railway, Manchester. Among the shipbuilding firms of the north they have in hand the yards of W. Gray and Co., Hartlepool; J. Reddhead and Co., Hebburn; A. Leslie and Co., Newcastle-on-Tyne; and Palmer's Shipbuilding Company, Jarrow. They have made a start in cotton mills, erecting lights at Messrs. Robert Macclure and Sons, Stockport Dye Works; and are rapidly completing the work at H. Ashwell and Co.'s, Basford, Not-

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tingham; Steine and Co., Liverpool; and at Messrs. Copestakes and Co., Nottingham. This firm has also carried out work at Brighton, Cockermouth, Chesterfield, &c. In all they have erected no less than 746 lights in the short period during which the concession has been in force.

Our information concerning the work of SIEMENS BROTHERS and Co. is very meagre. The motto of the firm seems to be—if we may in the midst of such sober details be allowed to make a parody—to do work by stealth and blush to find it known. However, among the work done we may mention the lighting of the districts for the city of London, comprising London Bridge, King William-street, Royal Exchange, Poultry, &c. The firm also has introduced the light into several large buildings, and we may specially call attention to the Alhambra and Savoy Theatres. We had hoped before this to have given an illustration of one of these theatres as it looks when lighted up, but have been prevented. At the Savoy Theatre the lamps used are those of Mr. Swan. Altogether there are over 1,200 lamps, requiring six sets of machines (exciter and distributer) driven by two of Fowler's engines. Owing to the resistances of the lamps not being identical the state of incandescence varies, but this will no doubt be remedied. We understand that it would have been remedied before the public inauguration if the lamps had arrived from the factory, and we think it hardly fair to criticise the light adversely before making inquiries, yet this seems to be what some of our contemporaries have done. The frightful accident at Vienna induced Mr. D'Oyly Carte to push on his idea of electric lighting for the theatre as fast as possible, hence we may take it for granted that shortcomings were unavoidable, but that they will disappear within a short time. We certainly think that in all cases of interior lighting secondary batteries should be used—whereby the cost would be considerably lessened and the chance of a total breakdown avoided. We know that Mr. Alexander Siemens will not leave the subject till he has thoroughly grappled with all the defects, and when one has witnessed the various details for connecting the circuits, for reducing and increasing the brilliancy of the lights, one is quite satisfied that the requirements have been considered, and that the problem of lighting theatres with a minimum of danger from fire is completely solved. What if the electric light should prove a little more expensive, a suggestion which we do not agree to for a moment. The risk from fire being lessened would compensate for this increased outlay. The first experiment on a large scale is always more expensive than the second.

Besides the work mentioned, Messrs. Siemens have installed the light at the Devonshire Park, Eastbourne; the Victoria Station, Manchester; Limerick Harbour, Rio Tinto Mines (Spain), Liverpool Corporation Water Works, Llanfyllin, Severn Tunnel Works, Portskewet, Blænavon Iron Works, and in the steamships "City of Rome," "Alaska," "Chimborazo," "India," &c. The firm is carrying out the lighting of the Winter Exhibition at the Royal Academy, and we believe the lighting of the Royal Society's rooms.

Before closing our review of electric lighting, we may call attention to the work of Messrs. D. and G. GRAHAM, of Glasgow, who carried out the first permanent installation of the electric light in mines, after, as has been shown previously, Mr. Crompton had proved its practicability at Pleasley. The work before Messrs Graham necessitated the formation of a company to carry it on, which has been formed under the title of "The National Electric Company (Limited)," with Mr. D. Graham as managing director. The first order executed by this company was that of the Glasgow Institute of Fine Arts, this being, we believe, the first picture gallery in the United Kingdom completely and successfully illuminated by the electric light.

INCANDESCENT LIGHTING.—The work of Mr. Swan in England, of Mr. Edison in America, as well as, to a minor extent, that of Mr. Maxim, Mr. Lane-Fox, Mr. FitzGerald, and Mr. Crookes, is so important that we cannot do justice to it in the short space now remaining, but must relegate this, as well as the question of storage batteries, to our next issue.

THE CABLE WORK OF THE YEAR.—The length of submarine cable made within the past year indicates no lack of activity in this particular direction; and when it is considered that the manufacture of a long cable means work in a variety of directions, such as wire drawing, shipbuilding, or adapting, &c., its importance can hardly be overrated. There are three firms of first rank employed directly in the manufacture and laying of cables, with other firms closely connected engaged in the manufacture of apparatus required in the laying, repairing, or working the cables.

The TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY has not during the year made the longest length of cable, but during its existence it has made no less than between 64,000 and 65,000 nautical miles of cable. The cable made during the past year has been principally for the Eastern and the Eastern Extension Telegraph Companies. The latter cable we have referred to in previous issues. It has been specially designed to resist the attacks of marine insects, and has replaced the Singapore-Batavia section of the company's cable. The cable made for the Eastern Company was to lay between Trieste and Corfu, whilst shorter lengths of various types of cables made for various companies bring the total to near upon 1,800 miles of cable. This work is exclusive of that carried on at the city factory, which, however, is more for the insulation of wire than for cable work.

The INDIA RUBBER, GUTTA PERCHA, &C., TELEGRAPH COMPANY (or, more sweetly and shortly, the SILVERTOWN COMPANY) has been very busy during the latter half of the year. The Central and South American Company have ordered some 3,100 nautical miles of cable, of which 2,500 nautical miles have been manufactured. India rubber core cable to the extent of 25 statute miles has also been manufactured for the same company for the underground connections between the huts and stations. Out of 300 nautical miles for the West India and Panama Telegraph Company 250 nautical miles have been completed. This last order was given on the 7th of October, so that 2,750 nautical miles of cable for these two orders have been made at Silvertown since August 13, 1881. The company during the year made 70 nautical miles of a 3·5 ton cable for the Great Northern Telegraph Company. Other 85 nautical miles in various lengths and types have been made and supplied to the English, Canadian, and Chilian Governments, and to the Submarine, International Ocean, and Direct Spanish Telegraph Companies. The length for the Canadian Government weighed 27 tons per nautical mile, having three sheathings. This brings the total for the year to over 2,800 nautical miles of cable. During the year this company, with its ss. "Dacia," and ss. "International," has laid the Brazos Santiago (Texas)-Tampico and the Tampico-Vera Cruz cables for the Mexican Telegraph Company. The "Dacia" also repaired the Havanah-Key West cable of the International Telegraph Company. The ss. "International" surveyed the route between Para and Cayenne and between Cayenne and Deme-

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rara for the Central American Telegraph Company. On her return from the West Indies the "Dacia" was chartered by the Post Office to repair and relay the Orkney and Shetland cables, which work was satisfactorily accomplished. The "International" left on the 9th November last to complete the Vera Cruz-Goatzacoalcos section of the Central and South American Telegraph Company's system. Mr. Theophilus Smith is in charge, assisted by Messrs. J. Rippon, J. Stoddart, and W. F. O'Brien. The "Dacia" left on the 15th November with cable for that company, to be laid on the West Coast of South America. Mr. W. F. King is in charge, assisted by Messrs. E. March Webb, chief electrician to the expedition, J. Kaye Gray, J. Rymer Jones, and others. They hired the "Retriever," belonging to the West Coast of America Telegraph Company, to make survey of route over which cables are to be laid. The Silvertown Company also repaired the Lizard-Bilbao cable of the Direct Spanish Telegraph Company with the ss. "H. C. Oersted," which was chartered from the Great Northern Telegraph Company, Mr H. Benest in charge. The company has also made all the instruments, testing and speaking, and batteries for the Central and South American Telegraph Company's ten stations, and have supplied the materials, wire insulators, &c., for the Goatzacoalcos-Tehuantessed land line, for the Santa Elena-Guayaquil land line, and for the other land lines for this company, amounting to 437 statute miles. They made during last year 119,000 Leclanché cells, of which 90,000 were the new Agglomerate form. The company has a very large business besides that connected with cables. We understand that the value of the telephonic work was not less than £10,000. The telephones principally made are, we believe, those of the Gower-Bell pattern. In electric lighting they have not been so busy, but have done fairly well in supplying engines, dynamo machines, projectors, lamps, and carbon rods. They have made deliveries to the Spanish and Argentine Governments. It may be interesting to state that at the Silvertown Works they have manufactured four wire sounding machines, Sir William Thomson's pattern, as modified by the company, and they have also made in their own workshops at Silvertown two cable machines for the French Government new cable works at La Seyne, near Toulon. The outcry against the English Government Department for not all at once putting the Department's lines underground ought to be somewhat modified, when it is stated that no less than 1,700 statute miles of insulated wire for underground work have been manufactured for it by the Silvertown Company. The use of Chatterton compound is avoided by covering this wire with one coat only instead of two coats of gutta percha, as is usual with other manufactures. This is claimed to be a decided advantage. The use of any compound containing Stockholm tar is avoided, the danger of which, and every other tar, being pointed out by Mr. W. Smith in a paper read before the Society of Telegraph Engineers. This brief history of the year's work at Silvertown gives a faint idea of the energy displayed in these works. We believe that the works are the largest of their kind in the world. The manufacture of telegraphic apparatus forms a large part of the work, as also does the manufacture of waterproof garments and fabrics, belting, bands, &c. The charge of the cable work is in the hands of Mr. J. K. Gray, and that of the instrument department in those of Mr. Foster. We recently visited these works, and hope shortly to give a detailed account of what we saw; meanwhile, we can safely state that every care was taken that the materials manufactured should be of the very best description.

During the past year Messrs. Siemens Brothers and Co. have manufactured and partly laid two submarine cables for an American cable company. These are known as Jay Gould's cables, but unfortunately we have not obtained any further information as to the length or type of these cables.

Hooper's Telegraph and India Rubber Works have been principally engaged during the past year in the manufacture of various lengths of torpedo and other cable for the British and Foreign Governments. In the early part of 1881 they manufactured the heavy multiple and single core cable which has been used in the line of telegraph just completed for the Chinese Government. In February, with the ss. "Hooper," they successfully laid a line of about 400 miles of their cable from Cienfuegos to Santiago de Cuba for the Cuba Submarine Telegraph Company (Limited). This line they have agreed to maintain in working order for twelve years, and as it consists of the cable rejected by the engineers of the Central American Telegraph Company (Limited) it will be interesting to note the result of Messrs. Hooper's guarantee. So far we learn that the tests of the cable are perfectly satisfactory, and the traffic through it is worked by one cell. The following tests of this cable are interesting:—

Date. 1881.	Temperature. Air.	Copper Resistance per knot mean.	Insulation resistance per knot, after 2 mins. electrification megohms.
May 1	89° F.	4·496 ohms.	10200
Dec. 4.	89° F.	4·509 ohms.	10470

Henley's Telegraph Works Company.—This company has made about 400 miles of submarine cable to be laid between Cuba and Belize. The cable is made with patent ozokerited core, conductor being 107lb., and insulation 140lb. per nautical mile. It is sheathed with 18 No. 13 homogeneous wires. They have also made several lengths of submarine cable for the Submarine Telegraph Company, the Great Northern Telegraph Company, the Eastern Telegraph Company, and the Montreal Telegraph Company, &c., and several lengths with the ozokerited core for the Swedish Government.

The Postal Telegraph Department has had some of the ozokerited core to be placed underground and overhead for telephone purposes. This core is manufactured upon the principle of laying up the wires in pairs, which effectually prevents inductive effects. This insulated wire is being tried by electric light engineers for electric light cables.

The following are the results of tests made by Mr. W. H. Preece with this core:—

Conductor resistance	23·723 ohms.
Capacity	·281 m.f.
Insulation	8,196 megohms.
Temperature	75° F.

Tests of Gutta Percha core of similar length:—

Conductor resistance	22·36 ohms.
Capacity	·273 m.f.
Insulation	860 megohms.
Temperature	75° F.

Professor Ayrton, writing to the Company on Nov. 24, 1881, says:—"You will be glad to hear that some specimens of your stranded wire cable sent me for testing have stood as high electromotive forces as 14,000 volts without breaking down, which shows that if care is taken in making this core the insulation will be quite sufficient for any existing system of electric lighting."

In connection with this question of insulation we may say that Messrs. L. Clark, Muirhead, and Co. have made and erected gutta percha machinery, and are now busily employed in covering ordinary wires for telegraphic purposes, and special cables for electric lighting. Particular attention has been paid to the production (with eminent success) of the new insulating material, "Nigrite," under the patents of Messrs. Field and Talling, of which the firm possess the sole

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and exclusive right of manufacture. This material consists of a mixture of pure Para rubber and ozokerit, or of gutta percha, rubber, and ozokerit as required, thoroughly mixed and masticated together at a low temperature, and put upon the wires in a similar manner to gutta percha. The principal features in this new material are said to be its extremely high insulating properties and its low inductive capacity (figures will be given at future dates).

Duplex Work.—This firm has also applied the well-known Muirhead duplex system to the D.U.S. Company's cable between Torbay and Rye Beach. The apparatus is being manufactured for the application of this system to the French Atlantic cable, and also to the two new American cables (Jay Gould's). The condensers manufactured by this firm are still in considerable demand owing to the excellence of their construction. It will be remembered that specimens of these condensers were exhibited at Paris.

The use of Muirhead's compound iron poles is yearly becoming more extended on account of their excellence and great saving in freight and inland transport.

In dynamos and electric lighting, &c., the firm have during the past year produced Dr. Hopkinson's patent electric hoist, and his permanent magnet alternating current machine. This promises to be extensively used on account of its power, compactness, and portability. They have also entered into arrangements with the Eastern Electric Light Company for the manufacture of the "Brush machine" lamp, and the "Lane-Fox" incandescent lamp, for use in India and elsewhere. The British Electric Light Company has also entrusted them with the manufacture of a considerable number of "Gramme machines" and "Brockie lamps." Considerable business has been done with the telephonic apparatus of the Western Electric Manufacturing Company of New York and Chicago, for whom Messrs. L. Clark, Muirhead and Co. are the sole European agents.

Our space is becoming rapidly filled, although the materials at our command are far from exhausted. We cannot conclude this portion of our work, however, without reference to one or two firms other than those mentioned.

Messrs. Johnson and Phillips, whose patent insulator has done such good service in some parts of Asia and elsewhere, have been generally busy in all departments. It may not be well known that this firm are making carbons for electric light purposes. We know that many of the electric light engineers are complaining of their inability to obtain good and trustworthy carbons, and it seems probable that, if Messrs. Johnson and Phillips continue to pay careful attention to the manufacture, the development of this branch of their work may assume very great proportions. They have also been busy in constructing buoys for cable work, &c., and in the departments connected with the electric light. They were the first makers of the Brockie lamp, now used by the British Electric Light Company.

Messrs. Felten and Guilleaume, of Mülheim-on-Rhine, have this year completed the German system of underground telegraph cables by laying down the last link, which is a duplicate cable from Cologne to Aix-la-Chapelle. The system now completed consists of 18 lines, and connects 221 towns. Its utility and efficiency have been tested during the recent heavy gales, when nowhere in Germany (excepting some of the overhead lines connecting the smaller towns) was the telegraphic communication interrupted, although in England and elsewhere in the centres of commerce interruptions were plentiful. The working of the German cable system is highly satisfactory, and it is the intention of the German Government to further extend it.

Also in galvanised telegraph wire Messrs. Felten and Guilleaume have been very busy, having, in addition to numerous contracts with European Governments, executed large orders for the English colonies, United States, and for the newly-established Chinese telegraphs.

WHAT IS ELECTRICITY?

We have received the following correspondence between Professor Sylvanus P. Thompson and Mr. James Johnstone for publication:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you be so good as to publish the accompanying correspondence? In Professor Thompson's last letter to me he excuses himself from continuing the correspondence on the score that he has more useful work to follow. I do not know of any more useful work a man can follow than that of endeavouring to establish the truth of his published writings when their accuracy has been called in question, especially when these writings are in the shape of "lessons," whereby to teach his fellow-men science, which ought to be truth, or it is worth nothing. This reason should have had all the more impression on Professor Thompson's mind, seeing that if he proved the truth of his writings he would receive payment of fifty pounds. That which no doubt operates on his mind in the opposite direction is that all the electrical phenomena mentioned in his book are explained according to the false theory of two electricities. Professor Sylvanus Thompson's assertions that my writings are fallacies and paradoxes are unscrupulous and unfounded assertions on his part. This correspondence opens up a wider question, namely, the demoralised condition of the contents of all the modern treatises on electricity which maintain that, when two substances are rubbed together two electricities are always produced, one on the rubber and the other on the substance rubbed. Faraday was a great stickler for this theory, but even he found by experiment, and was obliged to confess, that the foregoing is not always true. In the second vol. of his "Experimental Researches in Electricity," page 125, he writes:—"The mode of rubbing also makes, in some cases, a great difference, although it is not easy to say why, since the particles that actually rub ought to present the same constant difference; a feather struck lightly against dry canvas will become strongly negative, and yet the same feather drawn with a little pressure between the folds of the same canvas will be strongly positive, and these effects alternate, so that it is easy to take away the one state in a moment by the degree of friction which produces the other state. When a piece of flannel is halved, and the two pieces drawn across each other, the two pieces will have different states irregularly, or the same piece will have both states in different parts, or sometimes both pieces will be negative."

This confession of Faraday's completely demolishes the assertion made in all modern treatises on electricity about the rubber and the rubbed substance being always electrified by two different kinds of electricity.

Again, Faraday asserted, and all the modern treatises on electricity assert, that the two kinds of electricity are always produced in equal quantities—that they balance one another. Ocular proof can be given that this is not true. Take a Leyden jar, no matter what is its size, the larger the better, but the chief point to be attended to is that it be made of the kind of glass which proportionally to the size of the jar will enable it to receive a large charge of electricity, put such a jar in contact with the ball on the prime conductor of a frictional machine, charge it, according to the language of the two-electricity theory, with as much positive electricity as it can hold, then bring the ball of it in contact with a metal conductor in communication with the water pipes of the town, and note the size of the spark, or the amount of power of the charge. Then take the same jar, and, in the language of the two-electricity theory, charge it to its full capacity with negative electricity at the cushion of the same electrical machine, and then discharge it in the same manner as formerly stated. In the first of these experiments the size of the spark, or power of the charge of the so-called positive electricity is so enormously great compared with the spark or power of charge produced by the so-called negative electricity, that it is self evident that the two electricities do not balance one another, and are not in equal quantities. The truth is that when the Leyden jar is put in connection with the prime conductor of the frictional machine, the interior of the jar becomes surcharged with electricity, whereas when the same jar

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is put in contact with the cushion of the frictional machine the interior of the jar is robbed or depleted of its normal quantity of electricity, and hence it is easy to understand why the jar loaded at the prime conductor gives a large spark, and the jar applied to the cushion of the frictional machine gives a comparatively small and insignificant spark. The results here stated of these experiments with the jar cannot be inverted or overturned; they are strong proof of the utter absurdity of the theory of two electricities. There is much more I could communicate in proof of there being only one electricity, but I refrain for the present.—Yours, &c., JAMES JOHNSTONE.

Experiment Rooms, 1, James-square, Edinburgh,
29th December, 1881.

(Copy.)

Experiment Rooms, 1, James-square, Edinburgh,
14th December, 1881.

Professor Sylvanus P. Thompson, Bristol.

DEAR SIR: In your newly-published book of "Lessons in Electricity and Magnetism," at page 7, you write:—"Neither kind of electrification is produced alone; there is always an equal quantity of both kinds produced; one kind appearing on the thing rubbed and an equal amount of the other kind on the rubber." Under the supposition that the foregoing statement is true, when describing the action of the cylinder electrical machine you write (page 43):—"If it is desired to collect also the negative electricity of the rubber, the cushion must be supported on an insulating stem, and provided at the back with a metallic knob. It is, however, more usual to use only the positive electricity, and to connect the rubber by a chain to 'earth,' so allowing the negative charge to escape." Your writing here, "so allowing the negative charge to escape" is an assumption that a negative charge of electricity accumulates on the rubber and goes down to the earth. This assumption is a consequence of your previous assumption that "when two substances are rubbed together one kind of electricity appears on the thing rubbed, and an equal amount of the other kind on the rubber," and hence you say that "the chain on the rubber of a friction electrical machine is for allowing the negative charge to escape to the earth." That there is no such charge of electricity accumulated on the rubber of a frictional machine is demonstrated by the fact that if you apply an insulated test flame of coal-gas to the knob on the rubber of a frictional machine the insulated flame will show that a current of electricity instead of going from the rubber to the ground goes from the ground to the rubber. The frictional machine is, in fact, an instrument which takes electricity from the ground to the cushion, and from the cushion it is transmitted to the glass cylinder, and from the cylinder to the prime conductor, where it is given out under the form which you call positive electricity.

I am somewhat surprised that you have repeated in your new work (intended to teach the rising generation "Lessons on Electricity") the foregoing old and erroneous theory concerning frictional electricity. I cannot suppose that you are ignorant of the fact that a correspondence on this subject was begun in 1880 in *The Electrician* between Mr. Gordon, the assistant secretary of the British Association, and myself. In that correspondence I pointed out that Mr. Gordon had committed in his new work on electricity the same error which you have now committed in describing the action of the cylinder machine. In Mr. Gordon's letter of 24th October, 1880, to the editor of *The Electrician*, he acknowledged that the said description of electricity accumulating on the cushion of the electrical machine was wrong, and that he would rectify it in the next edition of his book. It is, therefore, remarkable that you should have republished the same old error, thereby misleading the minds of the rising generation.

In the interests of science I therefore ask you for some explanation of this matter.

The foregoing quotations, which I have given from your book, are evidence of the fact that throughout the body of your work you use the theory of two electricities when you are describing electrical phenomena. But in the preface, dated March, 1881, to your book you declare that there is only one electricity. I quote from it as follows:—"The theory of electricity adopted throughout these lessons is, that electricity, whatever its true nature, is *one*, not *two*; that this electricity, whatever it may prove to be, is not *matter*, and is not *energy*; that it resembles both matter and energy in one respect, however, in that it can neither be created nor destroyed." Here you say that "electricity is not matter and it is not energy," and therefore you must mean that it is spirit—at least, your assertion implies so. As we know that electricity exerts a powerful influence on all kinds of common matter, if electricity is not matter of some kind, but spirit, then this subject has a very serious aspect from a religious point of view. Therefore there is some explanation required.

Be so good as acknowledge receipt of this, and let me know if you intend to send me a reply, for if so I will wait any reasonable time for it; but if otherwise I will send this for publication without delay.—Yours faithfully, JAMES JOHNSTONE.

(Copy.)

University College, Bristol, Dec. 16, 1881.

DEAR SIR: Your discovery that if electricity be, as I hold, neither matter nor energy it must be "spirit" is worthy of such thinkers as Hegel or William Blake. It will hold in the future a very important place in these investigations of the relation between electricity and life, begun by Baron Reichenbach, and continued at the present day by a good many persons who think that the practical electricians are all wrong in their present way of thinking. The gold leaf electroscope will now become an instrument of vital psychological value. The torsion balance will enable us to weigh spiritual charges with the utmost precision. The Leyden jar will be contemplated henceforth with awe as the dwelling place of spirit, if not of life itself. I do not even despair of learning that some investigator—possibly yourself—will discover that it is instinct with life, and may possess powers of which now we little dream—such as spontaneous movement—though as a matter of fact I have not myself been able to detect anything of the kind. The theme is so vast that I leave it to one whose mind, like yours, soars into speculations beyond the reach of most of us.

Of course, I should be the last to deny that there may be in the universe other entities differing even more than electricity does from matter and from energy, and even less tangible to our perceptions.

As to the paragraphs of my book which you quote (not quite correctly in one place) I hope you will not, as so many theologians do when they want to establish some delicate point, detach them from the context by the light of which they should be read. You appear to hold (as I do) that electricity is *one*; but this view does not preclude me from also holding that there can be two different states of electrification; namely, a state of surplus in one place, and a state of deficiency in another; though I suppose it does not follow that because I find this point tenable, you with your acutely-trained mind will also find it so. Although there are two physical states of bodies, called "warm" and "cold" respectively, I hold that they are both due to one agent, "heat," which in one case is in excess, in the other in defect. But my holding this view is, I am aware, no reason that you should, in these days of liberty of thought, be prevented from taking a different view, as you probably will do, seeing that your mind has been, as I perceive by the pamphlet which you have been so good as to send me, trained to delight in theological refinements in which mine is relatively untrained.

I trust to your sense of justice to publish this my reply entire when your letter is published; and I reserve to myself the right to publish the letters if you do not.—I am, yours faithfully,

SYLVANUS P. THOMPSON.

James Johnstone, Esq., Experiment Rooms,
1, James-square, Edinburgh.

(Copy.)

Experiment Rooms, 1, James-square, Edinburgh,
19th December, 1881.

Professor Sylvanus P. Thompson.

DEAR SIR: In reply to yours of the 16th curt., I made no discovery that electricity is spirit, but your writings left it open for others to think that you held that opinion; and what you have added about entities in the universe still leaves it open for other men to quote your writings if they wished in support of their opinion that electricity is spirit, as you say it is "neither matter nor energy." I have no sympathy with the opinions of Hegel, William Blake, or Reichenbach, but the unqualified assertion that electricity is "neither matter nor energy" leads to results which are of too serious a nature to be treated with levity.

I sent to you a pamphlet, with special instructions that it was for your private use *only*, but owing to your having referred to its contents I am compelled to state that it is entitled "Some New Light from the Scriptures," and in it I prove from them that man possesses only one vital power, which is sometimes called soul and sometimes spirit, and that man does not possess both a soul and a spirit, as has been asserted for centuries by theologians.

In reply to your remark about "heat," in scientific writings it is not customary to use the words "warm" and "cold" as you have done; on the contrary, the usual practice is to state the difference of heat between two bodies by the degrees indicated by a thermometer, and the number of degrees so indicated are the measure (or, in the language of recent writers, "the potential") of heat between two bodies. So in the science of elec-

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tricity it is equally absurd to use the terms "positive" and "negative" if you believe that there is only one electricity; for a believer in one electricity, to be accurate, all he requires to do is to state in figures the potential of electricity one body has above another. To those who believe in one electricity only, the words "positive charge" and "negative charge" are as unscientific as the words "warm" and "cold."

As to the quotation I made from your preface, and that from page 7, they are word for word with your book. The quotation from page 43 is slightly shortened, but in doing so I have done you no injustice. If you still think I have done you injustice, please point out wherein I have erred.

In 1839 I published an account of experiments which led me to the conclusion that there is only one electricity, and I am delighted to find that you are a convert to this theory, although we differ as to the nature of electricity. You say it is not matter. I maintain that it is a peculiar kind of matter, not common matter. What puzzles me concerning your belief that there is only one electricity is that, throughout the whole of the body of your book, you do not give an account of any experiment to prove that there is only one electricity. When I published in 1839 my theory of one electricity I gave a description of the true action of the frictional machine, showing by experiment that only one electricity passed through it, and thereby, so far as the action of this machine is concerned, I proved that there is only one electricity. Now, I drew your attention to this subject in my letter, but you have avoided noticing this most important matter. You do not plead ignorance of a knowledge of the fact that, by the correspondence in the *Electrician*, I had laid before the public in 1880 a reprint of my proof of 1839 that there is only one electricity, as the frictional machine shows. Yet in the body of your book you give the untrue description of the action of the frictional machine in accordance with the theory of two electricities, but when writing the preface to your book in March last you had then become a convert to the theory of one electricity. Yet you do not assign any reason for this change. If you are in earnest in asserting that there is only one electricity, you ought to take an interest in showing to other electricians that only one electricity passes through the frictional machine. Be so good as let me hear from you on this point, that your reply may be published with this.—Yours faithfully,

JAMES JOHNSTONE.

(Copy.)

University College, Bristol, Dec. 20, 1881.

James Johnstone, Esq., Edinburgh.

DEAR SIR: If you wish to know why I cannot accept your view that electricity is a kind of matter I can only say that since the first and fundamental property of matter—the very property which makes us acquainted with matter—is that it *attracts* itself according to a law of universal gravitation, and since electricity happens not to possess this property, no amount of metaphysics or of syllogisms can bring me to believe that electricity is matter.

As to your experiments of the year 1839 there is an unproven assumption underlying the whole of them, namely, that a test flame moves in the direction in which electricity moves; which may, or may not be true, and which is no test at all until you have, by some other and independent process, proved that the electricity is really moving in the direction in which you assume it does. The fallacy of your inference is so transparent that I wonder you have clung to it so long.

Again, the person who argues that because a thing is not A or B it therefore *must* be C must first prove that it is not D, or E, or F. I have said that electricity is neither matter nor energy. You say it therefore must be "spirit." I fail to follow the argument. Vacuum is neither matter nor energy. A velocity is neither matter nor energy. A pressure is neither matter nor energy. According to your style of logic, each of these must therefore be "spirit"! Really, my dear sir, you must mend your logic, and learn, moreover, not to write "heat" when you mean "temperature," or "potential" where you mean "surface density," before you can expect scientific men to argue seriously with you.

You must kindly consider that I have more useful work to do than to expose your illogical arguments, your misuse of terms, and the flagrant assumptions that underlie your supposed proofs. —I am, yours faithfully, SYLVANUS P. THOMPSON.

(Copy.)

Experimental Rooms, James-square, Edinburgh,
23rd December, 1881.

Professor Sylvanus P. Thompson, Bristol.

DEAR SIR: Yours of the 20th was received yesterday. I have to reply:—

First. As to electricity being a kind of matter. I agree with you that it does not follow the common law of gravitation, yet it possesses the property of attraction for its own particles. When an insulated sphere is electrified by electricity from the prime conductor of a frictional machine, the electricity remains invisible over all its surface; but when an uninsulated body is brought near the insulated sphere the invisible electricity rushes together, and forms the mass of electricity which we call a spark. Now, the only possible way of accounting for this phenomenon is by coming to the conclusion that the scattered and invisible electricity became visible and united in the form of the mass called a spark by the attraction of the electricity for its own particles. I put it in the power of a committee of the Paris Congress of Electricians to award a prize of twenty-five pounds to any party who would give a better explanation of the above phenomenon. The offer of the prize was announced in the journals devoted to electricity, and there are plenty of electricians who would willingly take the twenty-five pounds, yet none of them attempted to give a better answer than the above. If you can prove by experiment that I am wrong in the above explanation of the said phenomenon, I will gladly pay you the prize of twenty-five pounds.

Second. As to the test flame. If a Leyden jar be surcharged beyond its normal quantity of electricity by being put into contact with the prime conductor of a frictional machine, on this jar being discharged the test flame invariably bends away from the ball of the jar, proving that electricity rushes out of the jar. If the same Leyden jar be depleted of its normal quantity of electricity by its being put in contact with the insulated knob on the cushion of a frictional machine, and then contact be made between this jar and the earth electricity will rush into the jar as indicated by the test flame bending toward the ball of the jar. These two inverse directions of the test flame invariably take place according to the manner in which the Leyden jar has been treated with electricity; the flame never turns toward the ball of the surcharged jar, and the flame never turns from the ball of the depleted jar. Until you or some one else can give some other reason for these reverse actions of the test flame with the surcharged and depleted Leyden jars than that of the flame being moved by the electricity going out of the surcharged jar and by that of the electricity going into the depleted jar, I hold that I have a right to maintain that the reverse motion of the flame in each of these experiments is caused by the reverse direction in which the electricity is moving. Can you show by experiment that I am wrong in this belief?

Third. I am much surprised that you should have compared a vacuum, a velocity, and a pressure as being on the same level of importance as electricity. It can be of no importance to mankind, although some men were to assume that a vacuum, a velocity, or a pressure were spirit because you had said they were neither matter nor energy; but the case is very different with electricity. The latter is a power which influences and acts upon all the various kinds of matter of which the world is composed. The earth's atmosphere is full of electricity, and the atmosphere is, to a certain extent, controlled in its motions by the action of electricity. Hence it is a serious matter if any body of men were to assume that electricity is spirit because you have asserted that electricity is neither matter nor energy.

Fourth. By the quotation from the forty-third page of your book already given in my letter of the 14th curt., it is manifest you teach that a charge of electricity goes from the rubber to the earth when a frictional machine is delivering electricity from the insulated prime conductor. Now, by the flame test I have found that this is not true. Electricity does not pass from the rubber to the earth when a frictional machine is in motion as above described; but, on the contrary, I have found by the flame test that electricity goes from the earth to the rubber of the frictional machine. I shall, therefore, give you an inducement to test the accuracy of the coal gas flame in indicating the direction in which electricity moves. I hereby promise to make you a present of £50 if you will, by experiment, prove that the insulated coal gas flame has deceived me in the action of the frictional machine. That is to say, I will pay you the said sum of money if you can prove by experiment that a frictional machine, when delivering electricity from the insulated prime conductor, sends another current of electricity from the cushion to the earth by the chain.—Yours faithfully,

JAMES JOHNSTONE.

(Copy.)

University College, Bristol, 27th December, 1881.

DEAR SIR: As you continue to cling to the fallacy of your supposed tests of the motion of electricity by the movements of a flame, it is obvious that there is nothing to be gained by continuing this correspondence. You will, therefore, kindly remember that I have other and more useful work to do than to discuss your paradoxes.—I am, yours faithfully,

SYLVANUS P. THOMPSON.

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THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.*

(*Continued from page* 119.)

We can now calculate the absolute values of the work done thus

$$\text{Total work } T = EI = \frac{E(E-e)}{R}.$$

$$\text{Motive power } T\,m = K\,E\,I = e\,I = \frac{e(E-e)}{R}.$$

$$\text{Heatwork or quantity of sensible heat } C = R\,I^2 = \frac{(E-e)^2}{R}.$$

It must not, however, be forgotten that these various works are developed in unit time, and that they should be divided by $g = 9{\cdot}81$ to give their values in kilogrammetres.

These values can otherwise be expressed in terms of the economic yield $K = \frac{e}{E}$. We have then

$$T = (1-K)\frac{E^2}{R},$$

$$T\,m = K(1-K)\frac{E^2}{R},$$

$$C = (1-K)^2\frac{E^2}{R}.$$

If it be desired that K should remain constant, and at the same time that the work done, as well as the energy expended, should remain constant whatever the value of R, that is to say, the distance of transport, it suffices that the quantity $\frac{E^2}{R}$ remain constant, or, in other words, that E should vary as the square root of R. It is almost needless to say that, $\frac{e}{E} = R$ being constant, e ought to vary in the same way, a result which brings us back to the rule already recognised for the transport of chemical and heat energy.

Some people cannot at first see how the yield is independent of the distance. It seems to them that the production of heat on the path of the current ought to increase with the distance, and consequently be a cause of loss increasing with it. This mistake arises from considering the loss per metre as constant, whereas it depends on the intensity of the current, which is itself a function of the distance. The preceding formulæ show clearly how things are, and demonstrate that if the work remain constant, the total loss in heat remains equally constant, since the loss per unit of length diminishes with the intensity.

Conclusions.

The laws of the transport of mechanical energy are as follow:

1. The positive mechanical work, representing the total energy expended, is expressed by E I. For a given intensity it is proportional to E.

2. The negative mechanical work is expressed by e I. For a given intensity it is proportional to e.

3. The economic yield is represented by the ratio of the negative electromotive force to the positive electromotive force.

4. The useful mechanical work and the economic yield remain constant whatever be the distance of transport, provided that the positive and negative electromotive forces vary proportionately to the square root of the resistance of the circuit.

These laws, as we may see, are the same for the transport of energy whatever its form. Not to neglect any point, it will be useful to remark, in discussing the values of I drawn from the formula $I = \frac{E \pm \sqrt{E^2 - 4RT}}{2R}$, that we have only considered the values affected by the sign +, and although this mode of examination, as is readily seen, does not alter the general conclusions, it is interesting to study the values furnished by the sign —. If we make $T = 0$, we will have $I = 0$. If we examine the value of e, we find $e = E$. This is a case that we have already met in studying chemical energy. The yield is equal to unity. The two positive and negative electromotive forces are equal. As they are contrary they annul each other, and produce nothing in the circuit, neither work nor current.

If we make T increase to the value $\frac{E^2}{4R}$, which, as we know, gives the maximum, we find a series of values of I increasing to $I = \frac{E}{2R} = \frac{I_0}{2}$.

We see, therefore, that for each value of T there are two values, one furnished by the sign +, the other by the sign —; that is to say, a given useful work can always be obtained with two different intensities corresponding to different electromotive forces.

(TO BE CONTINUED.)

* Abstract of a paper by M. Marcel Deprez in *La Lumière Electrique*.

VOLTAIC ACCUMULATION.*

We owe the *term* voltaic accumulation to M. Planté; we owe the *idea* of voltaic accumulation to him also. But more than this—we owe to Planté the rich results of a life devoted almost entirely to researches in connection with this subject. M. Planté employs the phrase voltaic accumulation in a double sense—to signify storage, and to signify cumulative effect. It is in this last sense that the term is generally used by M. Planté, and it is to voltaic accumulation in this sense that M. Planté has chiefly directed his attention. One of his principal aims has been to produce by means of voltaic accumulation the high tension effects usually obtained from the frictional electrical machine. At no very distant period the phenomena of voltaic electricity and of frictional electricity were so widely different, that a strong effort of the imagination and a clear perception of the laws governing these phenomena were necessary, in order to be able to entertain the belief that the agency which, led by naked wires, operated so quietly in causing the deposition of copper in large quantity from copper solution, could be the same which, bursting all bounds, rushed with flash and detonation to its goal.

When the platinum terminals of a voltaic battery composed of a few cells are made to dip in acid water, gas in torrents pours upward from them. If the same platinum poles, dipping in the same acid solution, be disconneeted from the quietly but powerfully working battery, and put in connection with the prime conductor and the cushion of a large electrical machine of the frictional type, you may turn the handle by the hour and produce an amount of electricity that would maintain a continuous stream of fire, and yet not a single bubble of gas will rise from the platinum poles. Moreover, the voltaic cells which decomposed the water so rapidly would give no shock, nor the tiniest spark through the smallest measurable space of air; while the chemically ineffective electrical machine would rack your limbs terribly and dart its spark through several inches of air.

At a very early period of the history of the voltaic battery it was known that by largely multiplying the series of cells, both sparks and shocks could be obtained from the terminal conductors; and, on the other hand, it was found that, by employing electrical machines of great power and forming poles of fine platinum wire coated with glass to the end, so as to reduce to almost a point the exposed surface of the platinum, water could be slowly decomposed.

In later years the two classes of phenomena characteristic of the voltaic battery and the electrical machine have made considerable advances towards each other. De la Rue has constructed a battery of 30,000 of his zinc and silver conple capable of producing a discharge through one-third of an inch of air; capable also of illuminating long vacuum tubes, and of producing other effects of high electric tension. At the Paris Electrical Exhibition I saw an electrical machine on the Holtz principle, composed of 30 glass plates of small diameter, which was capable of decomposing water freely, and of maintaining a thin platinum wire white hot as long as the plates were kept revolving. These approaches to identity of effect, by the electricity of voltaic action, of friction, and of induction, are of recent date. Before these results had been obtained, M. Planté, by means of methods the most ingenious, and experiments the most striking, completely bridged the gulf that separates the phenomena of high tension and low tension electricity. M. Planté has achieved this result by means of secondary voltaic action.

The charging and recharging of a series of 30,000 cells must evidently be an extremely troublesome operation. M. Planté avoids this trouble by making a few cells (two are sufficient) do the work of charging any number of secondary cells, which, after being charged, are joined in series and made to develop high tension effects. This is chiefly the kind of accumulation performed by M. Planté by means of his secondary cell, namely, the accumulation of tension or electromotive force. Here is a Planté cell. It consists of two plates of lead rolled together, but separated by narrow strips of gutta percha. These two lead plates being, to begin with, in the same condition, generate no current when immersed in dilute acid and united through the wire of a galvanometer. But if the couple be for a time connected, the one plate with the anode and the other with the cathode of a voltaic cell, or any other form of electrical generator capable of developing an electromotive force of not less than 3 volts, the anode plate becomes coated with peroxide of lead. If, then, the secondary cell be detached from the primary cells it will be found to be capable of generating a powerful current of about one-fifth more electromotive force than Grove's cell. When it is desired to obtain cumulative effects from a series of Planté's cells a mechanical arrangement is made whereby the plates of the different cells are so connected together that they are in effect one couple; that is to say, all the inner plates are connected together as one plate, and all the other plates are connected together as one plate. Arranged in this manner, if one of the poles of two Grove cells, coupled in series, be connected with the terminal which is common to all the inner plates, and the other pole be connected to the terminal common to all the outer plates, the same change takes place in the 100 or it may be the 1,000 cells as that which takes place in charging a single cell. That is to say, if all the outer plates were connected with the *positive* pole of the Grove cell, all these plates would be oxidised, and in this condition all the cells may be said to be charged just as a Grove cell is charged when one puts the nitric acid into it; for the highly oxidised lead of a Planté cell plays exactly the same part as the nitric acid of a Grove cell, and it is only necessary to alter the connection of one cell with another, so as to connect them in series, in order to obtain from them the cumulative electromotive effect due to their number.

Planté has devised a convenient method of making this change in the connections. This apparatus illustrates the arrangement.

The cells are arranged in line with a spring projecting upwards from each plate on each side of the line; between these two lines of springs an axle of ebonite runs, with metal bands so inlaid upon it, that when it is in *one* position all the springs on one side are pressing against a long strip of copper on that side, and all the other springs on a corresponding long strip of copper on the other side. In this position the cells are arranged for charging, the two long strips of copper being the two poles. When charging has been effected it suffices to turn the ebonite bar on its axis through a quarter of a circle in order to disconnect the springs from the two long

* Paper read by Mr. Swan before the Newcastle Chemical Society.

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strips of metal mentioned, and to bring them into contact with short strips of copper inlaid and insulated in the bar and crossing it obliquely so as to put the oxidised or positive plate of one cell in metallic communication with the non-oxidised plate of the next cell throughout the entire series. The change of connections is the work of a moment and the result is a multiplication of the electromotive force by the number of the cells.

I saw at M. Planté's house, which is also his laboratory, 800 cells arranged in this way, all charged from two Bunsen cells, which were placed outside the room on the window sill. By means of these 800 cells, worked in this convenient manner without the slightest annoyance from fumes or acids, the effects of about 900 Grove cells were obtained.

[Mr. Swan here illustrated the working of the apparatus by means of a battery of 20 small Faure cells arranged in a Planté commutating trough. When connected parallel, a copper wire was heated to whiteness and melted, and when in series, a Swan lamp was brilliantly illuminated.]

M. Planté went a step beyond this. He charged a large series of plates of mica, partly coated on each side with tin foil, on the principle of the Leyden jar. These were connected in charging and in discharging in the same manner as the secondary battery, that is, all the coatings of tin-foil turned one way were connected together, and all the coatings turned the other way were connected together. When, by the momentary joining of these two groups of plate coatings to the two poles of 800 secondary cells, the plates became charged, the connections were then changed from quantity to tension. By this contrivance the electromotive force of the four volts, due to the two primary Grove cells, was accumulated first to 1,800 volts and this again was increased fifty-fold by the mica plates. I can bear witness to the fact that it was sufficient to produce flashing discharges some inches in length, exactly resembling the discharges of a frictional electrical machine.

That is electrical accumulation in one sense, but there is another sense in which the phrase has been much used of late in connection with Faure's accumulator, namely, in the sense of storage. Planté's cell, with slight modifications, lends itself most perfectly to voltaic accumulation in the sense of storage. The very essence of the idea of storage is rententivity. The cell, to act as a reservoir or store, must be retentive of the charge communicated to it. This is a quality possessed in an eminent degree by the Planté cell. There is, comparatively with other voltaic cells which, but for the want of retentivity, might be employed for electrical storage, very little loss of charge by lapse of time within the limit of a few hours. But for the defect of loss of charge by local action—that is, chemical action not utilisable in the production of electric current, the zinc and copper cell of Daniell and several other well-known voltaic combinations not usually regarded as susceptible of being used as secondary cells might have been employed for electrical storage.

Perhaps the ideal of a cell for storage is Grove's gas cell. Here is a specimen of it; it consists of two gas tubes, and two plates of platinised platinum immersed in dilute sulphuric acid. If, while the tubes are filled with dilute acid, one plate is connected with the positive and the other with the negative pole of a voltaic battery, the one tube becomes filled with oxygen and the other with hydrogen, and when so filled the cell is an electric store capable, even after the lapse of a long time, of yielding a current.

But Grove's cell is quite out of the question for large operations, if only because platinum is so scarce. Theoretically it would perhaps be improved by making the hydrogen pole of palladium instead of platinum, so as to obtain the advantage of greater condensation of the hydrogen and thus to reduce the resistance by increasing the extent of the contact between the gases, the pole-plates, and the acidified water. Dr. C. W. Siemens communicated to the York Meeting of the British Association some interesting experiments in the employment of plates of carbon, both simple and platinised, as substitutes for platinum plates in the construction of a gas battery. The porosity of the carbon plates was utilized so as to bring the poles close together and greatly reduce resistance. The results obtained were well worthy of publication, although they did not quite reach the point aimed at, namely, practical utility for the electrical storage of energy.

I had imagined that De la Rue's cell, composed of zinc and silver incrusted with chloride of silver, might probably be employed in certain exceptional cases for electrical storage. On mentioning this very obvious idea to Dr. De la Rue, he told me there was a difficulty in the way, arising out of the tendency to the formation of oxychloride instead of chloride of silver.

For electrical storage on any large scale we look in vain to discover a better material than that fixed upon after infinite painstaking by M. Planté. Planté's cell, pure and simple, is a most admirable electrical accumulator in the storage sense of the word. It has one drawback, however, it requires a considerable time to give to the lead plates a large storage capacity. M. Planté's method of preparing his cell is as follows:—

The secondary cell is first filled with water acidulated with sulphuric acid (1 quart acid to 10 quarts of water), and on the first day it is charged by the current from two Bunsen cells six or eight times, the direction of the primary current being changed at each new charge. The secondary cell is discharged between each reversal of the direction, and it is ascertained either by heating a piece of platinum wire to incandescence, or by other suitable means, that the duration of the secondary current continually increases after each charge.

The time during which the secondary couple is submitted to the action of the primary current in the same direction is increased little by little.

Thus, on the first day, the period is increased from a quarter of an hour to half an hour, and one hour; and, finally, the battery is left over-night in the process of charging. The next day it is discharged, and then recharged for two hours in the opposite direction, then again in the previous one, and so on. But soon a limit is reached, beyond which the duration of the secondary current is not found sensibly to increase, especially when the primary cells, not having been removed, have grown by these successive actions little by little weaker, and have no longer sufficient intensity to cause the electrolysis to penetrate deeper into the interior of the lead plates.

The secondary couple is then left at rest for eight days, and at the end of that time is recharged in the opposite direction for several hours continuously, without making on that day a fresh alteration in the direction of the primary current.

Then the interval of rest is extended little by little to a fortnight, one month, two months, &c., and the duration of the discharge is found to go on continually increasing. It has, in fact, no other limit than the thickness of the lead plates. The positive plate, if it is thin, finishes by being almost entirely transformed by time into peroxide of lead of a crystalline texture; and the negative plate becomes formed by degrees, to a certain depth below its surface, of reduced lead of a granular and crystalline nature.

It is not always necessary to push the electro-chemical preparations of secondary couples as far as this complete transformation of the physical and chemical nature of the plates, for the couples would ultimately acquire a much greater resistance and take more time to charge them.

When the couples yield a current of sufficient duration for the purposes for which one wants them, it is no longer necessary to change the direction of the primary current each time the cells are charged. The quantity of peroxide of lead accumulated upon the positive plate would take too long to reduce, and no result would be got from the couple before several hours. A definite direction is therefore adopted, in which the secondary cells, when once sufficiently "formed," are always charged.

It is evidently desirable—more especially in view of the want more and more urgently felt as time goes on, of an accumulator which will be available for the large and important uses to which electricity will in future time be put—if possible, to avoid this tedious process of preparation so minutely described by M. Planté. No doubt it answers the purpose quite well when industrial applications are not in the question, but for electrical accumulators such as must be used in connection with a central system of electric lighting and which would probably involve the use of a set of large cells in every house, this slow process of preparation would be hardly applicable. It was with a desire to avoid this disadvantage and give to Planté's cells a greater capacity of storage, that I made the experiments last winter, the outcome of which was the modification of Planté's cell, which I showed you at our February meeting. Here are some of the cells I then exhibited in action. The idea of this modification was to increase the surface of the lead by means of lead foil, crimped and formed into frills, the interstices between the frillings being filled with electrolytically deposited spongy lead. The same idea has been applied in a somewhat different way by M. Faure in his accumulator. In M. Faure's accumulator red lead, mixed with dilute sulphuric acid, is plastered on lead plates, the coated plates are wrapped in felt, and either rolled up like the plates of a Planté cell or doubled together and placed in rectangular lead-lined wooden boxes. These cells have been made on a large scale, and for this reason, and because the application of the red lead coating greatly favours the obtaining of storage capacity effects have been obtained from them clearly pointing to practical use in electric lighting, and perhaps also for other purposes. The cell has, of course, the same electromotive force as the Planté cell, of which it is a modification; being large, it has, when fully charged, a small resistance, and is, on that account, capable of producing astonishing effects in the way of heating thick wire. [Heats some wire.] Thirty of these cells, weighing about 50lb. each, when properly charged, will keep twenty of my lamps up to 20 candle-power for several hours.

M. de Meritens has also made an accumulator on the Planté lines. The Meritens accumulator consists simply of plates built up of lead foil. Here is a representation of one of his plates shown in section. I have not any accurate information of the working of De Meritens' cell.

I have recently introduced into the construction of the Planté cell some modifications which, I anticipate, will increase its utility when applied on a large scale for the practical work of storage for electric lighting. One of my innovations consists in making the lead plates corrugated or cellular, the cells or grooves being filled with spongy lead, which from the form of the plate will remain attached to it without any external wrapping of felt or similar material being necessary. The felt in the Faure cell must, I imagine, be in a short space of time destroyed by the action of the acid, and occasion displacement of the material applied to the surface of the plate and held in its position by it. I have heard that it is proposed to substitute asbestos cloth for the felt; this, no doubt, will remedy the defect I have mentioned, but it must greatly increase the cost of constructing the cell. It is obviously desirable to avoid the use of any extraneous material, and the use of grooves or cellular plates accomplishes this object. I have made other improvements for the means of obtaining electrical storage, details of which I must for the present hold in reserve, but with the hope at some future time of bringing them under the notice of the society.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The ninth ordinary general meeting of this company was held on the 6th inst., at the City Terminus Hotel, Cannon-street, under the presidency of Sir Henry Drummond Wolff, G.C.M.G., K.C.B., M.P.

The MANAGING DIRECTOR (Major Wood) read the notice convening the meeting and the minutes of the last meeting, which were confirmed, and signed as correct by the chairman. The report of the directors, which was published in *The Electrician* last week, was taken as read.

The CHAIRMAN, in moving its adoption, stated that since their last meeting the shareholders had been informed by circular that the action which the company had undertaken against certain persons had been compromised in the manner authorised by that general meeting. The company had received the sums noted in the report (nearly the whole of the amount), and the amount still remaining unpaid was amply secured, and would be received very shortly. The working expenses had decreased by £4,525, and he thought they would see that, on the whole, the general prospects of the company were more satisfactory than they had been for some time. The maintenance was remarkably high for an enterprise of this character, but these charges were really more for renewal than maintenance, as the original deep sea type of cable which was laid in shallow water was not adapted for the purpose of shallow water, and had been exposed to more damage than would have been the case in deep sea, and more than another type of cable in these particular shallows. They had, however, by dint of this large expenditure, managed to replace the old type by a more satisfactory kind of cable, and they hoped in a short time that the whole of the revenue-earning portion of the cable would be entirely replaced by the sheathed type. They, therefore, confidently anticipated, especially when the new cable now ordered was laid down, that the maintenance charges every year would be very largely reduced. The question had arisen—and he had received

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letters from different shareholders—as to the application of the money they had received in consequence of the compromise they had entered into, and he had also received letters from shareholders suggesting that the directors should declare a dividend out of that amount; but he thought they would perceive that the declaration of a dividend out of this money was impossible without certain previous steps being taken in the courts of law. The sums they had thus recovered could not be looked on as profits. They were in no respect profits or revenue, but merely a replacement of capital, and must be treated as capital unless they obtained the authority of the Courts—which hereafter, if circumstances rendered it necessary, they would try and obtain—to reduce their capital by the process laid down in different Acts of Parliament. But even if they were entitled to divide this money among the shareholders as profits, which they were not, he scarcely thought it would be desirable to do so at the present moment. They had despatched Mr. Cunningham, the secretary, to Brazil, to try and come to some understanding with the Government with regard to the competition of the land lines. That competition had been very injurious to the Company, and he did not think that the Government had fully appreciated how unfair it was to carry it on. He had had communication with several persons who were competent to give an opinion, and their reports from Mr. Cunningham—which were very short, being telegraphic, as he had only been a very short time in Brazil led them to think that the authorities there were disposed to act favourably towards the company. Of course, such negotiations must take a certain length of time, but he thought the Brazilian Government, which had always been very just in its relations and dealings, saw the hardship on the company of the position in which they were placed, and did not desire that the capital ventured by British subjects in Brazil should be lost by any misunderstanding with the Government. More than that he could not say at present, because the negotiations were of a very delicate character, and he should not like to raise hopes which might not be realised; but he did hope that the negotiations were likely to be concluded, and before long he trusted that they would be in a far better position than they were at present. To revert, however, to the question of dividing the money, he should say that it would be unwise at present to part with any of the money they had received, because their position was much stronger in these negotiations when it was known that they had behind them a large amount of capital which might be employed in repairing their lines, guaranteeing the traffic—in fact giving an earnest of something profitable accruing to the Government, if the company could enter into a successful arrangement. He therefore hoped that the shareholders would support them in this view. The task before the directors was a difficult one, and had been up to the present moment, but they were now, he thought, in smoother water than they had been for some time. The intrinsic value of their enterprise had certainly considerably increased, both by the large amount they had spent in repairing their line and replacing unsuitable cable, from the increase of their traffic, and also from the position they were now in, by having a portion of their capital replaced. With regard to the Central American Company's line, they were of opinion that for the present matters had better remain as they were. They were in possession of the concession with their partners in that line, and of the necessary concession renewing it, should it be thought desirable to do so, but at present they thought it unwise to take up the question unless certain circumstances should occur to make them change that opinion. He had touched shortly on all the points likely to interest them, and he would be very glad—as would Major Wood also—to answer any question the shareholders might think necessary to raise with regard to the directors' report. He could not, however, conclude without once more expressing his own acknowledgments to Major Wood and Mr. Cunningham, as well as to their solicitors, for the great pains and care which they had displayed, and which had enabled them to make the compromise referred to. He might add that it was concluded on the advice of counsel. Counsel, in fact, were engaged at every step of the proceeding, and he hoped that the result would be considered satisfactory, and prove advantageous to the company. He concluded by moving the adoption of the report.

Mr. W. S. ANDREWS having seconded the motion,

Mr. BRANCH thought that the chairman had made one omission more or less important in the remarks he had addressed to the meeting. He had told them that certain proceedings had been adopted against certain individuals, and that certain money had been recovered. He (Mr. Branch) could understand why in their directors' reports and in the newspapers there should be this anonymous reference to the matter, but he could not understand why at their general meeting the names of the parties and the particulars of the case should not be given. If he were in order he should like to ask the amounts already paid by the individual defendants; who were those who had been left out of the compromise, if any; and what were the proceedings now being adopted by the directors to recover such further amounts as were in their estimation due. He did not wish to cast any doubt on the good faith of the compromise effected, either on the part of the plaintiff Company or the defendant individuals. He only wished to know who they were who had compromised, what they had paid, and the amount, if anything, they still held to be due.

The CHAIRMAN, in reply, stated that Mr. Branch had asked some questions which he did not think it would be quite appropriate for him to answer. In the first place, before they made this compromise, the directors summoned a general meeting of the shareholders, at which they stated the aggregate amount that was offered to the Company for the compromise, and they stated at the same time only that aggregate amount. They did so purposely, in order to avoid angry recriminations, which might have interfered with the progress of the compromise. The unanimous feeling of that meeting, which was testified to also by the large number of proxies they received, was that they should accept the compromise. They had done so, and he did not think it would be fair to those who had paid the money on the faith of the vote then come to by a general meeting for them to reopen the question or mention names. As far as he was concerned, and the other directors, they had really had no object in view but that of doing justice to the shareholders. None of the directors were concerned in the original establishment of the Company, and they came into it when the proceedings had already been begun. They had no knowledge of the subject except from the statements of complaint they themselves filed and the answers put in the defendants. They were not judges. It was not for them to decide or apportion blame or praise, or condemn or acquit any one, and he would not undertake such a task. They were offered a certain sum to compromise the whole proceeding. No one had been left out of the compromise. Every one had paid more or less, and he thought it would be far better to bury this proceeding instead of reopening the question. If, however, any shareholder would like to go to the office and see Major Wood, he thought they could give him the most satisfactory information on the subject, but he did not think that that was the place to make the statement. No one, as he had said, had been left out of the compromise. There was one gentleman who was out of jurisdiction, who he thought would come in, but with that exception, which was a small one, every one who was a defendant in the suit had contributed to the compromise.

Mr. PIKE—on behalf of another shareholder—asked why the directors had arrived at the conclusion that the Central American Company was worthless, and had struck it out of the assets of the Company.

The MANAGING DIRECTOR replied that, some little time ago, a surveying ship was sent to report upon the condition of the Central American Company's cable, their auditor, Mr. J. Weise, having for some time previously drawn attention to the fact that no return had been received on that portion of the assets of the Company. The survey was made, and the result, he regretted to say, was that the cable was not of any practical value.

The CHAIRMAN then put the motion, and it was carried unanimously. Continuing, he moved the re-election of Mr. H. Weaver as a director.

Mr. ANDREWS seconded the motion, and it was carried unanimously.

On the motion of Mr. D. H. GOODSALL, seconded by Major WOOD, Mr. C. W. Earle was also re elected to his seat at the board.

Mr. PIKE next moved, and Mr. ROBINSON KENDAL seconded, the reappointment as auditor of Mr. J. Weise, both testifying to the qualifications of that gentleman for the position.

The motion was carried unanimously, and the proceedings then terminated.

CUBA SUBMARINE TELEGRAPH COMPANY.

Report of the directors for the half year ending 31st December, 1881, to be presented at the twenty-first ordinary general meeting of shareholders to be held on the 18th day of January, 1882.

The directors beg to submit, duly audited, the balance-sheet and accounts for the half year ended 31st December last. From these it will be seen that the gross receipts, including the balance brought from last account, amount to £14,854 15s. 6d., and the gross expenditure, including the half of the annual payment for the new cable, to £5,689 10s., leaving a sum of £9,165 5s. 6d. to the credit of revenue account. After placing £1,000 to the reserve fund, increasing that fund to £42,000, and providing for the dividend on the preference shares, a balance of £5,165 5s. 6d. remains, out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 6 per cent. per annum, free of income-tax, leaving the sum of £365 5s. 6d. to be carried forward to the current half year's account. The directors have much pleasure in reporting that the cables continue in good working order, the new one remaining in the same excellent condition as when laid.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Jan. 11.		Business Done Week Ending Jan. 11. Highest.		Lowest.	
Anglo-American	48¼,	49¼	50¼		48¼	
Do. Preferred	75,	76¼	78¾		75¾	
Do. Deferred	20¼,	21	22		20¾	
Brazil Submarine	11¼,	11¾	11¾		11¼	
Cuba	9¼,	10	9 15-16		9 15-16	
Do. Preference	16,	17	—		—	
Direct Spanish	4¾,	5¼	5¼		5¼	
Do. Preference	14¼,	15¼	—		—	
Direct United States Cable	10¾,	10¾	10¾		10¾	
Eastern Telegraph	10¼,	10¾	10¾		10¾	
Do. 6 per Cent. Preference	12¼,	12¾	12¾		12¾	
Do. 5 per Cent. Debentures, 1899	105,	108	—		—	
Eastern Extension	11,	11¼	11¼		11	
German Union	9¾,	10¼	10		10	
Globe Telegraph and Trust Company	6¼,	6¾	6 9-16		6¾	
Do. Preference	12¾,	12¾	12¾		12¾	
Great Northern	11¾,	12¼	12¼		12¼	
Indo-European	28,	29	—		—	
Mediterranean Extension	2¼,	2¾	—		—	
Do. Preference	9¼,	10	—		—	
Reuter's	12¼,	12¾	12¾		12¾	
Submarine	290,	300	—		—	
West India and Panama	1¾,	2¼	2¼		2 1-16	
Do. 1st Preference	7¾,	8¼	8		8	
Western Brazilian	8,	8¼	8 9-16		7¾	
West. Union 7 per Cent. 1st Mortgage	123,	128	—		—	
Do. 6 per Cent. Sterling Bonds	104,	107	—		—	

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1 7-16	1 5-16
Oriental	⅜,	½	9-16	9-16

ELECTRIC LIGHT.

Electric Light and Power	1¼,	1¾	1 5-16	1¼
Anglo-American Brush	8¼,	9¼	9¼	8¾
United Telephone	11¼,	11¾	12¼	11¼

TRAFFIC RECEIPTS FOR DECEMBER, 1881.

Companies.	Dec., 1881.	Dec., 1880.	Increase.	Decrease.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	£2,500	£2,494	£6	—
Direct Spanish Telegraph Company	1,459	1,520	—	£61
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,319	28,010	3,309	—
Eastern Telegraph Company	49,844	46,776	3,068	—
Great Northern Telegraph Company	16,720	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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SLIP

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ended January 6, 13, and 20 amounted to £3,615, £3,789, and £3,768 respectively.

ELECTRIC LIGHTING FOR LEWISHAM.—The surveyor to the district board of works for Lewisham has been instructed to report on the comparative cost of gas and electric lighting for the district.

ELECTRIC LIGHT FOR REGENT-STREET.—The Laing Electric Light Company, the formation of which we noticed in a previous issue, will shortly light a portion of Regent-street by their system.

A CONCESSION.—The Postmaster-General has, in deference to a request from the Wolverhampton Chamber of Commerce, allowed the word "Wolverhampton" to be paid for as one word on all foreign telegrams.

THE TELEPHONE IN GERMANY.—According to a recent official estimate, there are now 900 miles of telephone lines in Berlin, 560 in Hamburg, and 100 in Frankfort-on-the-Main, Breslau, and Mannheim.

GREAT NORTHERN TELEGRAPH COMPANY.—The company's cable between Wladiwostock and Nagasaki has been repaired, and communication by this company's route with all stations in China and Japan is, therefore, re-established.

THE TELEPHONE IN DARLINGTON.—Telephonic communication between the fire and police stations at Darlington has been established. The apparatus, &c., was fitted up by Messrs. Harrison, Cox-Walker, and Co., of that town.

EASTERN TELEGRAPH COMPANY.—The next ordinary general meeting of this company is to be held on Thursday, the 2nd February, at the Cannon-street Hotel at two p.m. The report of the directors will be found in another column.

UNDERGROUND TELEGRAPHS IN FRANCE.—M. Cochery, Minister of Posts and Telegraphs, has decided that the underground cable in course of being laid between Paris and Lyons shall be extended to Marseilles.—*La Lumière Electrique.*

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending January 20, 1882, were £2,411, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE ROYAL SOCIETY.—At the meeting of this society on Thursday last, the following paper was to have been read by Mr. H. Tomlinson:—"The Influence of Stress and Strain on the Action of Physical Forces." Part II. "Electrical Conductivity."

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY.—The revenue of this Company for the month of October, 1881, is estimated at £1,860 (Western Brazilian portion £981, land lines £879), as against £2,264 for the corresponding period of 1880.

TELEGRAPHIC COMMUNICATION IN THE HERZEGOVINA.—Owing to the disturbances now taking place in this country, telegraphic communication is much interrupted. It is stated that the telegraph lines to Trebinje, Bilek, and Gatzko, near the Montenegrin frontier, are cut.

THE GOVERNMENT AND THE TELEPHONE COMPANIES.—A rumour was, according to the *Standard*, current on Wednesday last to the effect that the Government contemplated purchasing the telephone undertakings of this country. We have reason to believe there is no foundation whatever for this rumour.

COLONIAL TELEGRAPH REVENUES.—The revenue derived from telegraphs in the various colonies for 1880 is stated as follows:—New South Wales, £84,110; Victoria, £85,359; New Zealand, £73,002; South Australia, £55,152; Queensland, £46,313; Tasmania, £7,422.

LEGAL.—The case of the United Telephone Company *v.* MacLean was commenced in the Court of Session at Edinburgh on Tuesday last. The suit is brought to restrain the defendant from infringing the Company's rights by making and selling their patent transmitter.

A YOUNG TELEGRAPH CLERK.—A writer in the *Journal of the Telegraph* (New York) says that in 1880 he taught a child of seven years of age how to manipulate the instruments, and that "when he was eight years old he was fully qualified to take charge of a telegraph office."

THE ELECTRICAL TRAMWAY AT BERLIN.—Experiments which have been recently made at Berlin prove that two tramcars can easily be run on the same line of rails without affecting one another's speed. The experiments were made on the Lichterfeld Tramway in the presence of Dr. Siemens.

ELECTRICAL TRANSMISSION OF POWER.—On Sunday afternoon last Mr. W. Lant Carpenter, B. Sc., &c., delivered a lecture at the St. George's Hall, Langham-place, under the auspices of the Sunday Lecture Society. The subject of the lecture was "The Electrical Transmission of Power and Storage of Energy."

DIVIDEND.—The directors of the Direct United States Cable Company have resolved upon the payment of an interim dividend of five shillings per share, being at the rate of five per cent. per annum, for the quarter ending 31st December, 1881, such dividend to be payable on and after the 16th February next.

ELECTRICAL PATENTS, 1881.—From a perusal of the records of the Patent Office it may be roughly estimated that the following patents were taken out in 1881:—Electric lighting and appliances therefor 162, telegraphs and telephones 111, secondary batteries 28, other batteries 22, electric clocks 7, compasses 6.

THE PATENT OFFICE LIBRARY.—The latest addition to this extremely useful library is a set of all the specifications relating to electricity that have been filed in the American Patent Office from the earliest date up to the middle of last year. The specifications are given complete with the drawings, and are bound up in handy volumes.

ELECTRIC HEAD-LIGHTS FOR LOCOMOTIVES.—It is stated as a result of the recent trial with electric head-lights for locomotives on the Northern of France Railway that, although enabling the driver behind it to see well ahead, the light dazzled engine drivers approaching from the opposite direction. The experiments have, we believe, been discontinued for the present.

PRESENTATION.—Mr. F. M. Hodgson, of the Telegraph Department, G.P.O., son of the Rev. O. A. H. Hodgson, formerly vicar of Alton (Hants), has been presented with a silver coffee service from the Post Office officials, and a gold signet ring from his comrades of the Post Office Rifle Corps, on his leaving for Demerara to enter upon the duties of Postmaster-General of British Guiana.

CABLE LAYING OFF THE SCOTCH COAST.—The ss. "Marmion," of Leith, arrived at Silvertown on Saturday last, after a cruise of two months spent in repairing and laying postal telegraph cables on the west coast of England and Scotland. She has been taking in new cables for the Firth of Forth, Dundee, and Thurso during the week, and was to have sailed from the Thames yesterday.

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A New Electric Light Company.—The prospectus of the Hammond Electric Light and Power Supply Company has been issued. The company has a capital of £250,000, of which it is proposed at present to issue one-half. The company is formed to purchase from Messrs. Hammond and Co. their existing electric light business, including their "Brush" concessions and "Lane Fox" license.

English Telephones for Abroad.—With reference to our note of last week under this head, we are requested to state that the instruments supplied by Messrs. Harrison, Cox-Walker, and Co., of Darlington, for the Italian Telephone Company were their Cox-Walker electrophones, which were to be used as receivers for the Hunnings patent transmitter, and that the latter were not supplied by the above firm.

The Electric Light and Contractors.—We are informed that Messrs. Braddock and Mathews, contractors, are making use of the electric light on the works that they are carrying out for the West Lancashire Railway Company over the river Ribble. The Gramme machine and Brockie lamps of the British Electric Light Company are employed. The light was first used last Tuesday. The apparatus has been erected by Mr. H. Bury, of 25, Market-street, Manchester.

The Electric Light for the Colonies.—The electric light has in every sense a larger field for its operations in the colonies and India than in the Old Country. There it has to invade a field already occupied by gas. Here it will find itself in many cases without a rival. Even where gas is already supplied in the colonies the price is so high as to place electricity under much more favourable conditions as to comparative cost than in England.—*Colonies and India.*

Cable Legislation.—In reply to a question as to "first comers" in our article of Dec. 31 we are given by our contemporary who started the idea of indemnification a special answer, viz., a list of cable companies that should receive indemnity from a certain new company. We are thankful for the information, but would further ask—Did the said cable companies indemnify the fishermen, and if so, what fishermen, and further, by what right the said fishermen were recognised as first comers?

Telegraph Clerks in America.—A summons has been issued for a convention of telegraphists, to be held in Pittsburgh on the first Monday in March next, "for the purpose of forming an international telegraphers' organisation, having for its object the amalgamation of all existing telegraph organisations into one grand brotherhood." Each city, town, and division of road is to be represented by one delegate, and an additional delegate will be allowed for every fifty operators employed.

The Electric Light at Aberdeen.—The music hall at Aberdeen was recently very efficiently lighted by means of the Joel semi-incandescent and the Pilsen arc lamps. Twenty of the former and four of the latter were employed. The Joel lamps were fed by a six horse-power engine and two Siemens dynamo machines, and the Pilsen lamps by one engine driving a Schuckert dynamo. The lamps were erected by Messrs. Rowatt and Fyfe, of 52, Queen Victoria-street, E.C., and are said to have given great satisfaction.

Electric Light in Brighton.—It is stated that an experiment is about to be made by a number of tradesmen in Brighton with the electric light as a means of illumination for their shops. The Brush Company have undertaken to furnish the lamps and the power at a cost of £5 per week for each shop. The current will be generated at a central station (an iron foundry), and will be conducted to the various establishments (about a dozen in number) by wires suspended over the housetops. The Town Council have, we believe, decided not to make further experiments for using the electric light in the streets at present.

A Government Cable Depot.—We recently stated that tenders had been invited by the Government for the erection of a cable depot at Woolwich. This depot is now in course of erection, and will include cable tanks, offices, &c. The total cost is estimated at £10,000, and a staff of telegraph engineers will be attached to the works, which will chiefly be devoted to the Post Office cables round the coast and connected with the various islands in the British seas. Operations hitherto performed for the Government by private firms at a cost of some thousands of pounds per annum will now be carried out by the Post Office.

Electric Light and Telephone Wires.—The Philadelphia *Times* announces the invention by Mr. Plush, electrician to the Local Telegraph Company of that city, of a device whereby accidents from the contact of electric light and telephone wires will be prevented. The instrument is to be placed in telephone offices, and will form part of the circuit; an unusually strong current, caused by accidental contact with electric light wires or by lighting, will by the action of this instrument cause the circuit to be broken, without injuring the telephones or doing any harm. A patent is to be taken out for this invention, and thorough tests of its efficiency made.

University College, Nottingham.—On Friday last Professor Jenkin delivered his inaugural lecture to the students of this college on the subject of Galvanic Electricity. A course of lectures on the same subject in continuation of those delivered previous to Christmas on Magnetism and Static Electricity will be given by the Professor on Thursday evenings at 8 p.m., and will be preceded by a class at 7 p.m. The text book in use is Deschanel's "Electricity." Classes in electrical instrument making are held every Monday and Wednesday at 7:30 p.m. A class on Telegraphy is also held on the latter evening. The fee for each of the above is five shillings for the term of eleven weeks.

The Electric Light for Dundee.—Last Monday a deputation representing private firms and the shareholders of the Northern Electric Light, Power, and Appliances Company met a committee of the Dundee Gas Commissioners, to urge that the Commissioners should so frame their Bill that it should be made quite clear that private firms would not be interfered with in supplying themselves with the electric light. It was also urged that the Commissioners should adopt the Glasgow clause, securing the lighting of public streets and places to the Commissioners, but not interfering with private lighting. The Commissioners agreed to give every consideration to the requests of the deputation.

Electric Light for Harvest Work in Austria.—The electric light has done good service in parts of Austria during the past summer in enabling harvest operations to be carried on by night. The sun's rays are frequently so powerful, especially towards the middle of the day, that the men cannot work, and consequently much valuable time is lost to the farmer. A firm of engineers, however, hit upon the idea of using the electric light when the light of the moon was not sufficient to enable the work to be carried on by night. The farmers are said to have largely availed themselves of this means of saving time, and we are assured that this useful application of the electric light has proved a great success.

A Suggestion for the Next Parliamentary Session.—In a recent letter to the Prime Minister, Mr. Richard

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Herring suggests, as a means of facilitating the dispatch of business in the House of Commons, that "the Speaker should have authority to name an obstructive member, and at once to take the opinion of the House, the vote of the House being instantly recorded prominently on a vertical screen or on the table in front of the Speaker by a special electrical arrangement, supplying each member with the means of replying 'yes' or 'no' to the question without the necessity of leaving his seat, the switch connecting the battery for each vote being at the Speaker's sole command."

Radiant Matter from Electrodes.—As a proof that his views that so-called radiant matter consists of particles detached from the electrodes, J. Pulej describes in the *Chem. Centr.*, 1881, pp. 193-4, an experiment with cathodes covered with chalk. The cathodes shone with an orange phosphorescent light, and the walls of the glass vessel in a short time became covered with an exceedingly fine layer of chalk, and showed, in spite of their apparently complete purity and transparency, a phosphorescence like that of the chalk. The yellow stratum which first appears on metallic cathodes is a phosphoroscent phenomenon, due to a thin film of metallic oxide. The paper concludes with a detailed criticism of Goldstein's investigations on radiant matter.—*Journ. Chemical Society*, Jan. 1882.

The Temperature of the Voltaic Arc.—M. Rosetti has been studying, amongst other things, the temperature of the voltaic arc. He finds that the positive carbon attains a heat of 3,900°, and the negative 3,150°, the temperature of the arc itself being 4,800°. This latter is independent of the size of the arc and the intensity of the current. M. Rosetti uses as a formula for finding the temperature of any source of heat

$$Y = m\,T^2\,(T - \theta) - n\,(T - \theta),$$

Y being the galvanometer indication when connected with a thermo-electric pile acted on by the source, T the temperature of some radiant body, θ the absolute temperature of the medium in which the pile is placed, m and n the constants of the battery and galvanometer.

Electricity at Saltaire (Yorkshire).—At the annual *conversazione* at the Saltaire Institute, which took place last week, the hall was lighted by electric light. The *conversazione* was opened by a ball, one peculiarity of which was that the ladies' dresses consisted of British made stuff only. Lord and Lady Bective, Sir Titus Salt and others were present. The lamps used were the Brush, fed by a Siemens machine, the motive power for which was obtained from Saltaire Mill. During the week lectures were given by Professor Barrett of Dublin, which were very fully illustrated by experiments. Professor Barrett was ably assisted by Mr. L. J. Crossley of Halifax, who supplied most of the apparatus. Various lamps were shown, and also Faure's accumulators. A small Siemens electrical tramway was laid down the whole length of the lecture hall, and on this various people rode during the course of the evening.

Measurement of Chemical Affinities.—Mr. A. Tribe has found *(Chemical News)* that the magnitude of the intermediate space between the boundaries of the electro-deposits on metallic plates immersed in an electrolytic field, increase along with the force required to overcome the affinities of the ions of the electrolytes. In a series of experiments made with molecular solutions of zinc chloride, bromide, and iodide, with plates of Ag, Cu, Fe, and Zn, the intermediate space with the chloride was the greatest, less with the bromide, and least with the iodide. Further experiments with silver plates and molecular solutions of zinc and copper sulphates showed that the intermediate space in the case of zinc sulphate was the greater of the two. Experiments with zinc, iron, copper, and silver also gave results showing that the intermediate spaces corresponded with the order of chemical affinity.

Sound Changed into Light.—Prior to the invention of the photophone, M. Tréve (in 1879) is credited with experiments of an opposite character to those which developed this instrument. Instead of turning light into sound, he transformed sound into light. According to *Les Mondes*, a Fizeau condenser, consisting of sheets of paper alternated with tin foil, was rolled up and placed in a Geissler tube, which was connected with an air pump. The current from a Ruhmkorff coil was passed into the tube, and a telephone was placed in the induced circuit. While the current was passing, the sound produced by the electricity in the condenser could be heard in the telephone. If the pressure of the air in the tube was gradually lowered by the air pump, the noise died away, and when a vacuum of from two to three millimetres had been obtained, the noise ceased altogether, and light began to play against the leaves of the condenser.

Electric Lighting for Paddington.—The general purposes committee of the Paddington Vestry have presented a report on electric lighting. In this report it is stated that, taking the Brush as the cheapest of the three systems now at work in the City, the cost of displacing 76 public gas lamps and four Bray lamps between Edgware-road and the eastern end of Westbourne-grove would be about double. The above lamps cost at present £376 5s. 8d. per annum, including salaries and everything, whilst the electric light would cost £738 13s.; added to this there would be the first outlay for 16 electric lamps, &c., amounting to £1,963 8s., which would bring the price up to £2,702 1s. for the first year. This report is to be considered at an approaching meeting of the vestry. We would only remark that we wonder what the cost of gas would amount to for one year if the first cost of lamps, pipes, and, last but not least, gas works were thrown in?

An Item in Cable Work.—The following is taken from the *Times of India*:—"During the repairs of the telegraph cable near Bombay, the steamers "Chiltern" and "Great Northern" were about half a mile apart, the former having hold of a shore end cable, and so was in telegraphic communication with Bombay; the latter having hold of a sea end, and so was in telegraphic communication with Aden. The "Chiltern" desired the "Great Northern" to splice on to the cable-end held by the latter, and pay out three-quarters of a mile of cable, and this was communicated by wire from the test-room of the "Chiltern," passing through all the coils of cable in her hold and on to Bombay, whence it was sent on to Aden, and back from Aden to the "Great Northern." Thus, as a speedy means of sending a message half a mile, it was forwarded by a route between three and four thousand miles long. The following morning, when the two vessels were within a quarter of a mile of each other, communications passed between them constantly in the same way."

Swan's Lamps in Newcastle-on-Tyne.—The Swan incandescent lamps have been introduced into the premises of Messrs. Coxon and Co., drapers, of Newcastle-on-Tyne. The firm are said to have been endeavouring for some time past to obtain a better means of illuminating their establishment, and have finally entered into a contract with the Swan Electrict Light Company to fit up their lamps throughout. The lamps will be supplied with electricity by two of Siemens's dynamo machines, driven by an 8 h.-p. Otto gas engine.

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The system of lighting is divided into four sections, four cables leaving the generators, which are placed in the basement, and passing up into the manager's office, where controlling switches are placed, by means of which either one or the whole of the sections can be extinguished or lighted at once. A preliminary trial was made on Friday last, and was very successful, the light being soft, pleasant, and steady. We have no doubt that Messrs. Coxon's assistants will soon find out the difference between working in air that has been vitiated by gas and working in air where only electric lamps are burning.

South Wales Institute of Mining Engineers.—At the annual meeting of this institute, held recently at Cardiff, Mr. Thomas Canning read a paper on "Colliery Explosions and Atmospheric Electricity," giving an account of experiments made by the writer to ascertain the effect of lightning upon a coal mine. The result of those experiments was to show that explosions were often caused by atmospheric electricity, and as a remedy the use of conductors was suggested on a plan explained. In reply to those who asked, after all, was the danger so very great or very pressing? the writer would answer that the danger was certainly great in fiery mines when gas was present. Lightning was uncertain as to the time of its occurrence, and happened in a second, often leaving no trace save the destruction which it had worked. How many colliery explosions had been left unaccounted for? Assuredly they had not all been the result of electric discharges, but probably many of them had. If that were doubted—if the danger were not thought to be great and pressing—let observation be brought to bear, let statistics be collected, and the writer ventured to predict that the solution offered in the paper would be found to be the correct one. Papers were afterwards read on "Notes on Electricity," by Mr. W. H. Massey; "Electric Lighting for Collieries," by Mr. Wm. Thomas, F.G.S.; and on other subjects by different members.

Sixpenny Telegrams.—The following letter, signed by a "Telegraph Clerk," appeared in the *Morning Post* of the 24th inst.:—"I notice that the Chambers of Commerce intend petitioning for the much-wished-for sixpenny rates of telegrams, upon which subject I desire (with your permission) to make a few remarks. Supposing the Government are willing to grant this reform, there will be found a serious difficulty presenting itself, one which it will be no easy matter to overcome. It is apparent that, with a lower rate, there will be a much greater influx of messages, and, therefore, the staff at each large office must be substantially increased. But at the present moment there are numerous vacancies, yet none competent to fill them. How, then, can the authorities provide clerks to do the extra amount of work? It is very easy to say "take on learners," but telegraph clerks are not so easily made, as anyone connected with telegraphy knows that at least two or three years are required to make an efficient clerk. There are far too many recruits even now, which considerably lowers the efficiency of the service. During the past few years no less than between 2,000 and 3,000 resignations have taken place, the result of inadequacy of pay and slowness of promotion, to emphasise which I may mention that after nine years' faithful service I have attained a salary of £60 per annum. Nor has the promulgation of the new scheme checked the discontent and resignations to any great extent, because the manner of its distribution by the officials at St. Martin's-le-Grand is so very unfair that it makes it impossible to give satisfaction, as we hope to prove in the coming Session of Parliament."

Electric Light for Dudley (Worcestershire.)—The failure of the negotiations for the introduction of the electric light into Dudley has called forth a letter to a local paper, in which the writer criticises the action of the corporation. It appears that one effect of the proposed introduction of the electric light was to at once procure the erection of "four huge lamps of extra solidity and tall dimensions, with six burners each," by the local Gas Company. But it also appears that these lamps have all been grouped in one spot, and that in consequence a flood of light is given where it is not wanted. The correspondent above mentioned continues:—"But what benefit is that extra flood of light to the Market-place or the High-street, as now stuck in everybody's way around the fountain. It has been rumoured that many country yokels have taken them in good faith for the electric lights, and gone home rejoicing. . . . Had half-a-dozen of these monster lamps been judiciously fixed, two in the Market-place, and others at the corners of such streets where the curves are very sharp, then we should have been able to have seen whether the six-burner light was likely to supersede the electric light. I am well acquainted with the town of Barnsley, where *the spirited corporation* have recently put into operation in their Market-place and main streets the electric light. The effect is marvellous, and very pleasant and acceptable to the inhabitants; but it has had another very agreeable result for the benefit of the inhabitants—viz., that the gas rate to the consumers has already been reduced 5d. in the thousand feet, and the street lamps 5s. per lamp. Such being the gratifying results of the electric light, surely our mayor and corporation will not relax their efforts to introduce the the electric light into Dudley."

Electric Apparatus at the Frankfort Theatre.—At a recent meeting of the Electro-Technische Verein of Frankfort-am-Main, Herr Carl Wagner, the chief engineer at the Grand Opera House, gave some interesting details of the way in which electricity is there employed as a preventive of accidents. There appear to be four different uses to which it is put, viz., 1. An electric fire alarm; 2. An electric temperature indicator; 3. Means for controlling the movements of the various attendants; 4. Lighting the gas by electricity. The fire alarm consists of eight large alarum bells, the hammer of which is held back by a magnet as long as the circuit is complete, but the moment it is broken by any means the alarum bells at once begin to ring. The temperature of any part of the house can be ascertained as follows:—A number of thermometers specially designed to give an electric signal when the mercury rises beyond a certain point are placed in various parts of the house. These are connected by wires with the office of the chief engineer, and with the room in which the heating apparatus is placed. By means of these thermometers and the apparatus connected therewith, any official, by pressing a certain button in his office, will be able to read on a board on which a disc appears the number and temperature of the room which is connected with the particular button pressed, and if required a current of hot or cold air can at once be sent to the room in question. If the temperature should rise abnormally from any cause in any particular room, the thermometer will automatically cause an alarm to be given, indicating that the temperature of the room is too high. By another simple arrangement the chief engineer can ascertain whether all his *employés* are at their posts. The lighting of the gas is produced by causing a spark to pass between two platinum points which are fitted to each gas burner. From the above account it would seem that Frankfort is very far ahead of other towns in its provisions for the safety of the theatre-going portion of its population.

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TELEPHONE EXCHANGES.

The Western Electric Manufacturing Company of New York seems to have paid a good deal of attention to the requirements of small telephone exchanges; in fact, it is to America that we owe the idea of exchanges. We have had in England the Exchange Telegraph Company working in the distribution of news, of prices of stocks, &c., for many years, but the telephone exchange pure and simple is an outcome of Graham Bell's work. It is well understood that the various subscribers to a telephone exchange are connected to a central station, and that by means of switch-boards they are put into communication one with another.

We herewith illustrate some of the arrangements of the above-named company, whose agents for Great Britain are Messrs. Clark, Muirhead, and Co. Fig. 1 is especially adapted for exchanges with less than 500 subscribers in one office, that is for small towns or suburban districts. It is very compact, each section (as shown in the figure), for 50 lines occupying only a width of 14 inches, the height being $5\frac{1}{2}$ feet.

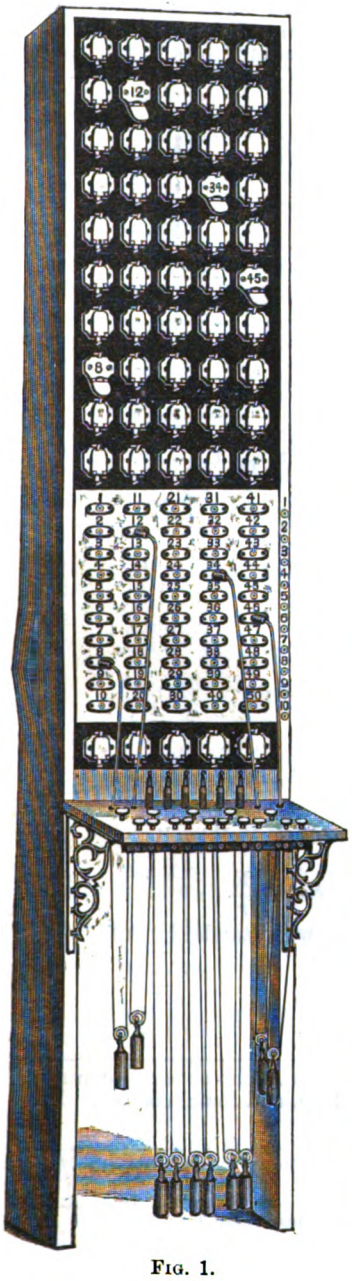

FIG. 1.

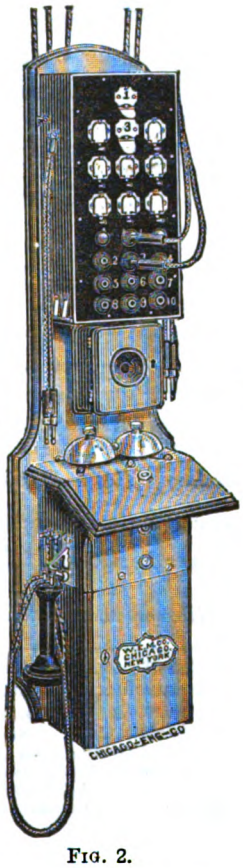

FIG. 2.

FIG. 3.

The annunciator drop is said to be very sensitive, and so arranged as to act equally well with a current from a battery or from a dynamo machine. An attachment on the drop closes a local contact and rings a bell, to call the attention of those in charge. The pony switch-board, Fig. 2, is a complete telephone exchange for a small number (under 25) of wires, and is mounted on a board, as shown, with a call box. The operation of the board consists simply in inserting plugs, with cords attached, in the spring jacks of the subscribers wishing to be connected.

The magneto call box, shown in Fig. 3, is simple. It is mounted on a base board, with battery box. The telephone switch is so arranged that the circuit can never be left open.

It is evident that the introduction of the telephone, like the introduction of all other aids to civilisation, has its influence upon various industries. This will be seen again when the electric light is more widely used for interiors. Brass workers, wire drawers, &c., may reckon upon an extended field of usefulness. It is too late in the day now to speak of the utility of telephonic exchanges. The time will arrive, and that soon, when not only houses of business, but private houses will be connected with, and transact a large amount of business by, such means.

There is, as our readers well know, one feature about telephone exchanges which we have constantly regarded as a sign of weakness. We refer to overhead wires. We cannot but acknowledge that the numerous wires and standards erected over our streets have withstood the wind and snow storms very well; but, as time passes on, the constant strain must tell and, sooner or later, accidents will happen. In several towns action has been taken by the authorities because of the interference of overhead wires with the passage of the fire-escapes, and accidents have more than once occurred through such a collision. Some of the roofs over which scores of wires are erected may be brought under the influence of fire, and in falling it would be hardly possible to foretell the result of the extra strain upon the wires. It is a weakness in the system that the companies must consider and alter. According to the Western Company, the Brooks underground cable system, which we referred to in Vol. VII., pp. 181 and 216, is in use throughout America both for telephone and telegraph lines. In Milwaukee there are eight such cables, and in Chicago four, mostly 50-wire cables. Some of these cables have been in use for several years, and show no signs of deterioration. We should be glad of more specific information on the subject. Do the companies continue to lay new cables on this system as the extension of operations may require?

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PHOTOMETER TESTS OF ELECTRIC LAMPS.

(Reprinted from the *Engineer*.)

SIR: The paper by Professors Ayrton and Perry, which recently appeared in your pages, directs attention to an important question, namely, the photometric power of various systems of electric lighting. I have recently carried out experiments to ascertain this power, and as regards certain lamps, and I think the results I have obtained may interest your readers. The accompanying engraving shows the arrangement of the apparatus, and beneath it are given the rules followed in making the tests. In the tables annexed the results are so fully set forth that I do not think much explanation concerning them is needed.

The accompanying diagram, Fig. 1, with rules for taking tests, are those I have devised, and found easy of manipulation.

As in Professors Ayrton and Perry's tests, given in a recent number of *The Electrician* (vol. viii., Nos. 3 and 4), the observations are confined to the lamps only. The lamp to be tested was simply removed from its position in the electric light circuit, and placed in the photometer, the ends of the leads L_1 L_2 taking its place on the main leads, so that its condition while under test was as nearly as possible the same as before.

The photometer was constructed on Rumford's direct shadow principle, which I find answers very well for incandescent lamps up to 15 or 20 candle-power. When higher candle-powers are obtained, it becomes a matter of personal judgment, and two observers will not give precisely the same results, owing to the great difference in colour of the two shadows—viz., that from the candle and the incandescent lamp.

While accurately determining the resistance of the German silver wire, which is marked in the engraving above, G.S.W., 30^{ω}, No. 16 B.W.G.—which means that it has to be about 30 ohms resistance, and, say, No. 16 Birmingham wire gauge—by means of a Wheatstone bridge, &c., it is advisable to take the resistance of all the lamps (cold) that are afterwards to be tested by the special method both cold and hot, in order to prove the accuracy of the connections and galvanometer in the special test.

The principle employed in determining the resistance of the lamps, both cold and hot, by the special method, is that of comparing the deflections obtained on a high resistance galvanometer—placed in very high resistance circuit—joined up as a shunt, first to the known and the accurately determined 30^{ω} of German silver wire, and, secondly, to the lamp under test. Then,

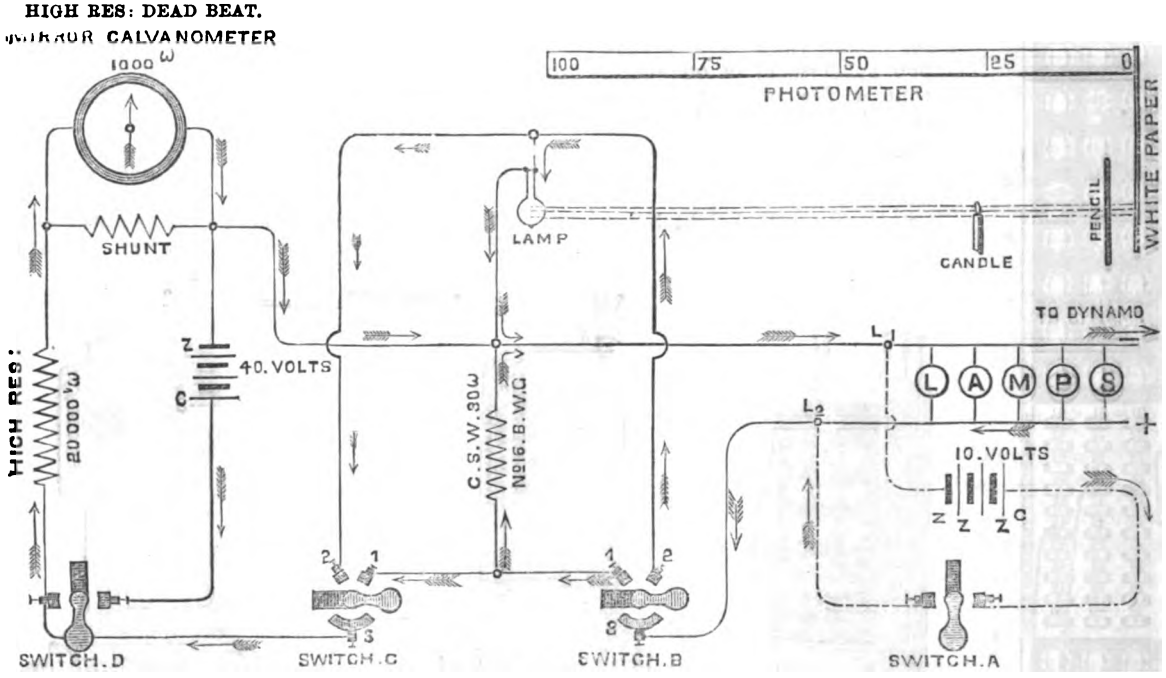
For Res. cold $D_1 : D_2 : : 30^{\omega} : R.$

For Res. hot $D_3 : D_4 : : 30^{\omega} : r.$

The electromotive force, or difference of potential between the terminals of the lamp when hot, is found by comparing the deflection obtained from the same with that of a battery of known electromotive force.

$\therefore D_5 : D_4 : : 40^{\text{volts}} : E.$

The candle-power is always obtained at the same instant as the resistance hot and the electromotive force; and three or four minutes suffice for getting all the necessary deflections from one lamp for working out the details as given in Tables I., III., and IV. (see note at foot of previous column), when once the connections have been satisfactorily joined up, and found correct.



RULES FOR TAKING TESTS.

Resistance Cold.—Free dynamo leads L_1 L_2. Close switches A B (1-3), C (1-3); take deflection D_1. Close switches A, B (2-3), C (2-3); take deflection D_2.

$$\because D_1 : D_2 : : 30^{\omega} : R \because \frac{D_2 \times 30}{D_1} = R \text{ (Res. cold) } \omega.$$

Resistance Hot.—Free switch A; join on dynamo leads L_1 L_2. Adjust shunt; find D_3 and D_4 by same plan as D_1 and D_2.

$$\because D_3 : D_4 : : 30^{\omega} : r \because \frac{D_4 \times 30}{D_3} = r \text{ (Res. hot) } \omega.$$

Electromotive Force.—Free switches A, B, C; close switch D; take deflection D_5.

$$\because D_5 : D_4 : : 40 : E \because \frac{D_4 \times 40}{D_5} = E \text{ (E.M.F.) volts.}$$

Current per Lamp (Hot).—C (Ampères) $= \frac{E}{r}$.

Candle-power = K (from comparing with standard candle).

Horse-power per Lamp.— $\frac{E \times C}{746}$.

Candles per Horse-power.— $\frac{K \times 746}{E \times C}$.

TABLE I.

Electric and Photometric Tests of Swan's Lamps, taken at Messrs. R. E. Crompton and Co.'s Testing Room, Queen-street Station, Glasgow, May, 1881. The generator employed was a Burgin Machine made by R. E. Crompton and Co. The total number of lamps in circuit being 52 (13 *parallels of* 4*in. series*). (*Bunsen's Photometer used.*)

No. of lamp.	Res. cold by test Fig. 1. Ohms. (R)	Res. hot. Ohms. (r)	E.M.F. Volts. (E)	Current Ampères. (C)	Candle-power. K	Horse-power per lamp. $\frac{E \times C}{746}$	Number of candles per horse-power.
6B	76	44	43·6	·99	7	·058	121*
1	—	28	45	1·6	17	·099	171·7†
2	—	22·9	43·5	1·9	18	·11	168·6†
3	—	30·1	45·2	1·5	20	·090	222·2†
Mean of 1, 2, & 3.		27	44·56	1·6	18·3	·0996	185·8

* This lamp is one of a few of those tested at the time.

† No attempt was made to push the lamps higher, but simply to measure them as they would be under ordinary circumstances.

[The accuracy of the results of tests as given in the original Table IV. having been questioned, the tests are being repeated in Sir W. Thomson's laboratory with his newest-designed apparatus, and when these tests are completed we shall give the results.—ED. *Elec.*]

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Table II. speaks well for the life of Swan's lamps, when used at a low candle-power; and the miners seem, so far, satisfied with the light given. I am of opinion that the increased length of life which can be got out of an incandescent lamp of the Swan type, when used at a low candle-power, will outweigh the increased economy in power obtained by using them at a higher temperature or candle-power.

TABLE II.

December 9th, 1881, 11 a.m. Life of Swan's incandescent lamps at Earnock Colliery. Date of installation, August 11th, 1881. Number of hours the lamps are lit daily is 10½, except Sundays and Saturday afternoons, or sixty hours per week.

No of lamp.	Date put in.	Date of breaking.	Cause of renewal.	No. of hours lighted.	Lamps now in use. Hours lighted.
1^1	Aug. 11th	—	Still lighted	1,040	1,040
2^1	Ditto	Aug. 25th	Carbon broke	112	
2^2	Aug. 25th	Sept. 10th	Ditto	130	
2^3	Sept. 10th	Oct. 5th	Ditto	210	
2^4	Oct. 5th	—	Still lighted	560	560
3^1	Aug. 11th	—	Still lighted	1,040	1,040
4^1	Aug. 11th	Sept. 7th	Carbon broke	230‡	
4^2	Sept. 7th	—	Still lighted	800	800
5^1	Aug. 11th	Sept. 7th	Carbon gave way	222‡	
5^2	Sept. 7th	Sept. 8th	Ditto	10	
5^3	Sept. 8th	Sept. 13th	Ditto	50	
5^4	Sept. 13th	Sept. 22nd	Ditto	360	
5^5	Sept. 23rd	Sept. 26th	Ditto	20	
5^6	Sept. 26th	—	Still lighted	640	640
6^1	Aug. 11th	Sept. 17th	Carbon broke	312	
6^2	Sept. 17th	Sept. 21st	Ditto	30	
6^3	Sept. 21st	—	Still lighted	680	680
7^1	Aug. 11th	—	Still lighted	1,040	1,040
8^1	Aug. 11th	Oct. 11th	Carbon broke	520	
8^2	Oct. 11th	—	Still lighted	510	510
9^1	Aug. 11th	Sept. 13th†			
9^2	Sept. 13th	—	Still lighted	750	750
10^1	Aug. 11th	Aug. 23rd	Carbon broke	120	
10^2	Aug. 25th	Oct. 19th	Ditto	470	
10^3	Oct. 20th	—	Still lighted	430	430
11^1	Aug. 11th	Sept. 7th	Carbon broke	230‡	
11^2	Sept. 7th	—	Still lighted	800	800
12^1	Aug. 11th	Sept. 7th	Carbon broke	230‡	
12^2	Sept. 7th	Oct. 10th	Renewed owing to giving bad light	280	
12^3	Oct. 10th	Oct. 24th	Carbon broke	120	
12^4	Oct. 24th	—	Still lighted	400	400
13^1	Aug. 11th	Sept. 7th	Carbon broke	230‡	
13^2	Sept. 7th	Oct. 11th	Ditto	290	
13^3	Oct. 12th	—	Still lighted	500	500
14^1	Aug. 11th	Sept. 7th	Carbon broke	230‡	
14^2	Sept. 7th	—	Still lighted	800	800
15^1	Aug. 11th	—	Still lighted	1,040	1,040
16^1	Aug. 11th	Sept. 26th	Broke by accident	382‡	
16^2	Sept. 29th	Nov. 26th	Carbon broke	500	
16^3	Nov. 26th	—	Still lighted	110	110
17^1	Sept. 30th	—	Still lighted	600	600

Lamps are numbered from the bottom of shaft inwards 1^1 to 17^1. Renewals are marked 5^2, 5^3, 5^4, 5^5, and so on.

‡ On September 7th, from some unknown cause, five lamps gave way—viz., 5^1, 11^1, 12^1, 13^1, 14^1—marked thus ‡.

* No. 9^1 lamp put into No. 5^4 with a previous life from August 11th—280 hours. No. 5 is next to the bottom of the shaft, where the men could switch it off and on with ease, which may possibly account for frequent renewals. Since the switch was removed the lamp has not required renewal.

† Shifted to replace No. 5^4, and therefore called No. 5^4.

N.B.—Lamps Nos. 1^1 and 3^1 were measured by Mr. Gilchrist and self in the cabin at foot of shaft, and gave 6·25 and 6·5 candles respectively. The others in the mine were apparently about the same power. I got the above from Mr. Gilchrist, manager of Earnock Colliery, who reported it to the Mining Institute of Scotland.

TABLE III.

Electric and Photometric Tests of Maxim's Lamps, taken at the Electric Power and Generator Company's Works, London, July 27th, 28th, and 29th, 1881. Total number of lamps in circuit, 21. Total current generated, 36 Ampères, registered by Siemens' electro-dynamometer. The Maxim exciter and generator machines were driven by leather belting from a counter shaft, which in turn was revolved by means of a pair of horizontal fixed engines. Speed of exciters 610 revolutions per minute. Speed of generator, 776 revolutions per minute. Maxim's patent automatic current regulator was in gear and worked very well. It was thrown out of gear when trying a single lamp very hard.

No. of lamp.	Res. cold by bridge. Ohms.	Res. cold. By test, see Fig. 1. Ohms. (R).	Res. hot. Ohms (r).	E.M.F. Volts (E).	Current through each lamp. Ampères. (C).	Candles from comparison with one of Sugg's standard candles. (K).	H.P. per lamp. $\frac{E \times C}{746}$	Number of candles per H.P.
1	50·5	50·7	28·8	60·	2·08	24·6	·166	150
2	53	53·5	29·5	58·4	1·98	24·6	·155	160
3	61	—	34·41	60·94	1·77	11·8	·144	83
4	60	—	37·1	61·87	1·66	9·6	·137	70
5	69	69	44·77	60·62	1·35	9·1	.109	83
6	51	—	29·3	58·12	1·97	30·	·152	196
7	48	—	26·85	58·75	2·18	26·7	·171	156
8	48	49	27·75	57·81	2·08	29·	·161	180
9	66	—	—	broke	—	—	—	—
10	51	—	31·99	60·0	1·87	21·1	·150	141
11	53	—	30	59·37	1·98	24·6	·155	160
12	59	58·8	38·75	60·62	1·54	9·6	·125	77
Mean	54·86	—	32·65	59·68	1·86	20·0	·154	132
Special trial of Nos. 6, 8, and 2 alone. Only one lamp in circuit at a time.								
6	51	—	29·16	64·06	2·19	31·7	·188	170
,,	,,	—	29·28	76·25	2·6	61·	·265	230
,,	,,	—	28·84	78·12	2·7	153·	·282	542
,,	,,	—	22·87	95·3	4·16	430·	·532	808
,,	,,*	—	—	—	—	—	—	—
8	48	—	24·4	89·	3·64	200·	·432	462
,,	,,	—	23·25	97·	4·17	660·†	·542	1,220
2	53	—	26·85	106·2	5·05	590·	·562	1,050

Carbon gave way after being kept nearly 15min. at about 600 candles.

* After increasing the current still further the carbon filament gave way. † Carbon broke at 800 candles.

ANDREW JAMIESON, Principal,
January, 1882. College of Science and Arts, Glasgow.

THE EASTERN TELEGRAPH COMPANY.

Report of the directors to the nineteenth half-yearly ordinary general meeting, February 2nd, 1882. The directors submit the accounts and balance-sheet for the six months ended 30th September, 1881. The company's revenue for the period amounted to £282,834 8s. 9d., from which are deducted £67,498 5s. 5d. for the ordinary expenses, and £47,228 15s. 5d. for expenditure relating to repairs to and laying of new cables during the half year. After providing £3,040 14s. 4d. for income-tax, there remains a balance of £165,066 13s. 7d., to which is added £2,723 6s. 7d. brought from the preceding half year, making a total available balance of £167,790 0s. 2d. From this balance, £22,726 9s. 2d. has been paid for interest on debentures, and £20,559 1s. 6d. for dividend to 30th September, 1881, on the preference shares, leaving a balance of £124,504 9s. 6d., out of which the directors have paid two interim dividends on the ordinary shares for the quarters ending 30th June and 30th September, 1881, amounting together to £95,000, leaving a balance of £29,504 9s. 6d. to be carried forward to next account. It will be observed that since the last report the directors have issued the balance of 700 ordinary shares, making the total ordinary capital £3,800,000. The several sections of the company's cables are in good working order, with the exception of the Direct Lisbon line, which is now under repair. Reference was made at the last general meeting of shareholders to the interruption of the cables between Aden and Bombay, which had occurred in shallow water close to Bombay. Notwithstanding the prevalence of the south-west monsoon, communication was temporarily restored on one of the cables on 10th August by the company's repairing staff, sent from Aden, and the use of the Peninsula and Oriental steamships "Geelong" and "Timsah." Subsequently, on the 25th August, the second cable was temporarily repaired, by the ss. "Great Northern," belonging to the Eastern and South African Telegraph Company, from Zanzibar. On the arrival of this company's ss. "Chiltern" at Bombay with new shore ends, they were permanently laid in a carefully selected channel. The presence of the two steamers enabled this to be done without any delay to the traffic. The revenue includes £19,500 dividend and bonus for the half year upon the company's shares in the Eastern and South African Telegraph Company (Limited), the dividend being at the of 6 per cent. per annum, and a bonus at the rate of 4 per cent. per annum. The revenue account also includes £2,652 19s. 2d. dividend for the half year on the shares of the Black Sea Telegraph Company (Limited) belonging to this Company, by which the line is worked and maintained under agreement. The directors regret to announce the death of Colonel Thomas George Glover, R.E., on the 12th September last, and of the Right Hon. William Nathaniel Massey, M.P., on 25th October last. The directors have, under the powers given to them by the articles of association, elected John Denison Pender, Esq., to a seat at the board in place of Colonel Glover, and Lord Sackville A. Cecil to fill the vacancy occasioned by the death of Mr. Massey. In accordance with the provisions of the articles of association, two of the directors, viz., the Marquis of Tweeddale and George Garden Nicol, Esq., retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Mr. Henry Dever and Messrs. Quilter, Ball, and Co., also retire, and offer themselves for re-election.

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THE DANGERS OF ELECTRIC LIGHTING.

Now that the scare which a few alarming accidents in connection with electric lighting gave rise to some weeks ago has quite subsided we may venture to offer a little sober advice on the subject. It was useless to interpose at the time, for anything that might have been said to allay the excitement was sure to have been interpreted either as depreciating the electric light or as denying its danger—a denial that would have been little heeded in the presence of the actual facts. There is, however, no reason why we may not admit the danger without in the least admitting that it is one that may not be incurred with perfect safety. The multiplication of highly dangerous compounds, and the contrivance of exceedingly dangerous machinery, have gone on now for some centuries past without being in the least impeded by fear of contingent consequences; and, on the whole, our confidence has been justified by comparative immunity from disaster. The destructive forces which lie slumbering in gunpowder or in dynamite, and which, under certain conditions, may be awakened in coal gas, are pre-eminently potential dangers; but we have learned to store these commodities with safety and to use them without fear by adopting precautions which are as simple as they are efficacious. If an explosion occur we at once pronounce it the result of accident, unless some culpable negligence or stupidity is discoverable; and what we say about these painful occurrences connected with electric lighting is that they belong to one or other of two categories—accident or ignorance—and are not "dangers" at all in the popular sense of the term.

What the alarmists probably meant when they preached about the dangers of electric lighting was that to all appearance the risk of accident was greater than it is in any other system of lighting. The mistake here is in the assumption that actual accidents are a measure of the legitimate risks. In the early career of any new invention capable of inflicting personal injury this assumption is very unreasonable. The true nature of the risks to be guarded against have to be ascertained, and the needful safeguards are introduced as experience may seem to demand. The electric light is in its infancy, and if all due precautions have not been taken in respect to it, this may be a subject for regret, but it is by no means one for alarm or discouragement.

As a matter of fact there is no more danger in lighting by electricity than in lighting by gas or mineral oil. Electricians would say not so much, and probably they are right. We have grown so familiar with gas, and manipulate it with such confident fingers, that we have almost forgotten that there are any risks attached to it; the true explanation, however, being that we forget the danger by habitually remembering the precautions. But this was by no means the case in the early days of gas lighting; explosions were not infrequent, and many a conflagration has been traceable—is still traceable—to an unnoticed escape of the inflammable mixture. The use of explosive mineral oil for domestic purposes must be classed amongst still more hazardous risks; yet it is notorious that the consumption of paraffin as an illuminant is enormous, and this especially amongst the most ignorant and careless portion of the community. The precautions here are of the flimsiest description, and when we remember that the chief protection against an outburst of flame—a flame, too, very difficult to extinguish—is a bit of frail glass or an ill-fitting screw, the wonder is that paraffin lamps are ever admitted inside an inhabited house. But the most reckless of men and the clumsiest of women have learned to employ this homely and economical light with perfect confidence and safety. There is risk, but the danger has practically disappeared.

It may be said, however, that we may buy our experience over dearly. Be this as it may, it is tolerably certain that if the public are bent upon possessing an accessory to the comfort or convenience of life they will have it. But this in passing only, for we by no means argue that men may be killed and buildings set on fire in order that we may learn so much by experience. On the contrary, we have such faith in theoretical electrical science that no experience of that baneful kind seems to us at all necessary to demonstrate the risk, such as it is, incurred in practical electrical engineering.

And this naturally brings us to consider whether the mishaps that have thus far occurred in connection with electric lighting are the result of pure accident or of ignorance. On some few occasions circumstances have combined to bring about a fatality which could hardly have been avoided by adopting every reasonable precaution. On others the due precautions are missing, and we are constrained to admit that the general arrangements have not been made with knowledge. There are two classes of accident which are excusable in the first trials of a new and unfamiliar undertaking; the one due to the ignorance of the workman, the other to some detail overlooked or not foreseen by the master. Both these elements of danger entirely disappear

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after a little while; wires are handled with impunity because the conditions of safety are well known; and fire is prevented because the places of possible outbreak are duly protected. If there is a third class of accident it must be due to over-haste or ignorance on the part of the promoters and their *employés*, either of which we cannot but own the newspapers would be justified in condemning as culpable. They will not be slow to do this when they have acquired a little more knowledge of the system their public duty requires them to criticise; and it behoves everybody interested in the promotion of electric lighting to take care that such criticism shall not be deserved.

On the whole, we are not disposed to regret the spasm of alarm which took possession of the daily press a little while before Christmas. It has cooled down now, and electrical engineers will themselves be to blame if it break out afresh. The nature and extent of the protection needful in the case of wires charged with powerful currents are perfectly well known to every competent person; and any company taking upon itself the task of laying down such wires would, we need hardly say, incur grave responsibility if thoroughly competent persons are not engaged to superintend the work

ON THE THEORY OF DYNAMO AND MAGNETO MACHINES.

VII.

Mechanical Actions between Currents and Magnets Further Considered.

Before going on to the subject of current measurement, which though only an outskirt of our subject is yet one that it is most important properly to understand, we will consider in the light of the fuller information contained in Arts. V and VI. the motion of some electro-magnetic pieces of apparatus such as we began to discuss in Art. IV. The importance and direct bearing on our subject of these electric motors must be apparent on reflection that any one of them, if set in motion by hand, will generate an electric current. We are not, however, yet considering them in this light, neither will we do so until we have attended to the theory of work and energy as applied to electric currents, and have shown that the production of currents by electro-magnetic engines is a direct consequence of the conservation of energy.

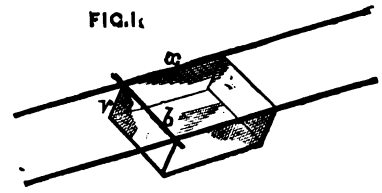
Consider, first, the simplest case of a pair of rails and a slider, or axle, as shown in Fig. 1, Art. IV. When the axle rolls along through x centimetres, the area it sweeps out is $b\,x$, and the number of lines of force added to the circuit is the vertical magnetic intensity multiplied by the area $b\,x$. The vertical intensity of magnetic force may be represented by a line of certain length drawn downwards (for the case of the earth's magnetism a line ·44 units long); so the product $\cdot 44\,b\,x$, the gain in the number of lines of force, is geometrically represented by the volume of a rectangular parallopiped whose length is x, breadth b, and depth the vertical intensity.

Suppose, instead of drawing a *vertical* line to represent the *vertical* intensity, we drew a slant line to represent the earth's force both in magnitude and in direction; then the figure enclosed between this line and b and x is a parallopiped of precisely the same volume as before, and therefore equally well represents the gain in the earth's lines of force; or the loss of potential of the circuit; or the work done during the motion per unit of current circulating round it.

Notice, further, that there is no need for the area $b\,x$ to a rectangle; the axle might be set skew on the rails, but the volume of the parallopiped would be unaffected, and the work done per unit of current would be the same. The axle need not even be straight; for, provided only that it be moved parallel to itself, the area swept out, and the volume representing the loss of potential, would be unaltered.

And the proposition will bear generalisation beyond this; for, suppose the rails to be crooked and not parallel, and the slider to be of any plane shape (or even flexible), and to move in any manner in the plane of the rails, it will sweep out a certain plane area; and this area, multiplied by the component of magnetic intensity normal to the plane, will still measure the number of lines of force added to the circuit, or the work done during the motion per unit of current. And it will be represented geometrically by the skew cylindrical (or prismatic) volume, which has the area swept out by the slider as base, and the total intensity as slant height.

FIG. 1.



Returning, again, for simplicity to the original parallopiped (Fig. 1) with adjacent edges x b and V (if V represent for an instant the earth's vertical magnetic intensity), it is interesting to note that the face $V\,b$ of the rectangular block represents by its area the number of dynes urging the slider to move per unit of current. For it represents the work done per unit current while the distance moved is unity. If the current sent through the slider is of strength γ, of course the force is $V\,b\,\gamma$, and the work done by displacement x is $V\,b\,\gamma\,x$; but as the geometrical representation of this would require space of four dimensions we will not attempt it.

In the more general case, when the slider has any shape whatever (plane or otherwise), it is to be understood that the effective area it sweeps out is the projection of the actual surface traced by it on the plane of the rails; and the area which represents the force causing the motion (per unit of current) is to be understood as the projection of the parallelogram area contained between the length of the slider and the magnetic intensity on a plane perpendicular to the rails.

It is scarcely necessary to remark that the force producing the motion, and the work done by the motion, will both be *nil* as long as no current passes. The force and the work are both strictly proportional to the strength of the current.

FIG. 2

As to whether the work done is positive or negative—whether it is done *by* the slider upon external bodies, or done by external agents *upon* the slider—that depends simply upon the sense of the current as compared with the positive direction of the lines of force. One way of remembering this direction is to swim with the current and look along the lines of force (*i.e.*, look along them in the direction in which the north seeking pole of a magnet points and tries to move), then you will experience a force urging you to the left,* and work will be done *by* the slider in which you swim if it so moves.

Another way, and a very handy one, of remembering the

* Note that looking along the lines of force is not the same thing as looking at a north pole. If you look at a north pole the lines it sends out are coming up toward you, and to look along them you must turn your back upon it. Hence the above is quite consistent with Ampère's well-known rule that if you look at a north pole it is urged to the left; yourself in that case feeling a force to the right. Remember that the north pole of the earth is magnetically austral.

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direction in which motion tends to take place is this. Hold out the thumb and first two fingers of your right hand so as to be as nearly as possible at right angles to one another (like the adjacent edges of a box); then point with your fore finger along the direction of the current, with your second finger point along the lines of force, and the thumb will indicate the direction in which motion is tending to take place; *i.e.*, will indicate the direction of the force urging the conductor to move. (Fig. 2.)

Thus refer to Fig. 1 in Art. IV., or in this article; hold your right hand over the slider with the fore finger pointing along the arrow, point downwards with the second finger to show the sense of the earth's magnetic field (in northern latitudes), and the thumb will indicate the motion.

In using this method it is essential to remember which of the three fingers is to point out what; you may not use them promiscuously. It is also essential that you use the *right* hand.

Another way, again, is to think what is the sense of the lines of force actually produced by the current itself as it circulates; then if the lines in the magnetic field agree with these, their number passing through the circuit tends to increase.

Yet another way is to think first of the direction of the current, and then of the direction of the lines of force, and to imagine yourself screwing an ordinary right handed corkscrew into a cork, with the twist indicated by these two directions; then the direction of advance of the corkscrew is the direction of the force acting on the circuit. (If it should happen that the above two directions coincide there will be no force at all.)

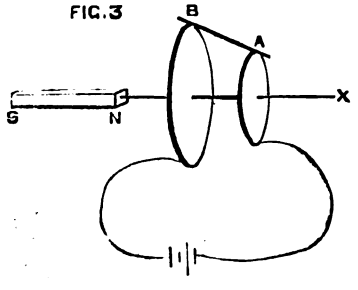
The ends of the rails in Fig. 1 may be joined together so that the two rails are concentric circles (or any other closed curves): the slider can now revolve continuously under the action of the earth's magnetism as soon as each rail is joined to one pole of a battery.

Revolving of a Current round a Pole.

Consider now the case of two circular rails arranged so as to have a common axis, round which the slider can revolve; but instead of the earth's force *let a magnetic pole, or any number of magnets, be placed on this axis*, and consider the tendency to motion of the slider as soon as it is made to convey a current. The slider may be of any shape whatever.

This is really the same thing as investigating the action of a magnet on any portion of a circuit free to move independently of the rest. For since the natural tendency of a current is, we know, to revolve round a pole without increasing or decreasing its distance, the circular rails on which we have placed the ends of the slider subject it to no constraint, but simply afford a convenient means of maintaining the continuity of the current, notwithstanding the motion.

FIG. 3



Consider, first, only the single pole N of strength m. Call the angle A N X, α, and the angle B N X, β. Then the number of lines of force which pass through the small circle A will be $2\pi m(1 - \cos.\alpha)$ by Arts V. or VI. The number passing through the large circle B is $2\pi m(1 - \cos.\beta)$; and the difference of these two quantities is the number of lines passing through the portion of space between A and B, viz., those which, after passing through the circle B, pass outside the circle A. These are they which will be cut by the slider, no matter what its shape, if it revolve once round. The number is

$$2\pi m(\cos.\beta - \cos.\alpha)$$

and this we may denote by N.

The work done while all these lines are cut, that is, during one complete revolution of the slider, while conveying a current γ, is $N\gamma$. But if G is the moment causing the rotation, the work done during a revolution through the angle 2π is, of course, $2\pi G$. Therefore we have

$$2\pi G = N\gamma = 2\pi m\gamma(\cos.\beta - \cos.\alpha);$$

or the moment is

$$G = \gamma m(\cos.\beta - \cos.\alpha).$$

So much for one pole. If we consider the whole magnet we shall simply have to subtract the effect of the other equal opposite pole at S, the result being,

$G = \gamma m(\cos.ANX - \cos.BNX - \cos.ASX + \cos.BSX)$. And so in general if there are any number of poles of strengths, $m_1, m_2; \ldots$ at points $P_1, P_2, \ldots$ all on the axis, the rotating moment they exert on a linear conductor A B, of any shape, conveying a current γ from A to B, is

$$\gamma\left\{\Sigma(m\cos.APX) - \Sigma(m\cos.BPX)\right\}.$$

The noticeable thing about this expression is that the couple tending to make a conductor revolve about a magnet or magnetic axis is independent of everything except the position of its end points, and the strength of its current. Moreover, we see that if these end points, A B, lie symmetrically with respect to a magnet, so that $ASN = BNS$, the revolving couple will be *nil;* in other words, one of the two poles of the magnet must be nearer the moving portion of the circuit than the other in order to produce rotation.

The couple will be also *nil* if A and B both lie on a prolongation of the axis of the magnet; or, again, if A and B coincide with each other. Hence a *closed* circuit has no tendency to revolve as a whole round a magnet; it does tend to *rotate* on an axis of its own, so as to set itself normal to the lines of force; but, if this tendency be prevented by hinging it on to the axis of the magnet, it makes no attempt to *revolve.*

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The first meeting of the present session of this Society was held on Thursday evening, the 19th inst. A motion expressing its sense of the loss sustained in the death of its eminent member, Mr. L. C. Schwendler, was adopted by the meeting, and Professor Foster having announced a valuable gift of books to the Society's library, received from the Meteorological Society, on the subject of atmospheric electricity, the presidential chair was vacated. A vote of thanks to the retiring president, proposed by Mr. W. H. Preece and seconded by Professor Adams, was then put to the meeting by the newly-elected president, Lieutenant-Colonel Webber, and carried by acclamation.

The brief abstract of the president's inaugural address which we were enabled by the courtesy of the Society to give in our last issue conveyed but a very imperfect idea of the range and extent of the subjects dealt with by him; nor, indeed, can we find space for a full report now. The history of the Society from its inception, and the work it had achieved during the ten years of its existence were fully gone into. Based on the principle of liberality, and not upon exclusiveness, the Society had attracted the professors and students of electrical science, as well as those who were engaged in its practical application throughout the whole world. The terms of subscription were low, and in this particular our example had been followed by the eminent society in whose rooms we were permitted to meet. The activity displayed in scientific research and invention during the period referred to, and the severe competition which was the natural accompaniment of that state of things, had enabled the Society to occupy the position of impartial critic, greatly to the advantage both of the public at large and the inventors themselves. The ultimate test of utility would always in this country be applied on commercial principles; and nothing could better determine the commercial value of a new idea or a new invention than a society like theirs, where discussion and criticism were free to all. As an illustration of this, Colonel Webber men-

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tioned that most ingenious but costly instrument, the type printing machine, which, if practical considerations had not prevailed, might have been the instrument adopted by the postal telegraphs of this country, the consequence of which would most probably have been to delay the development of telegraphy in a popular direction for an indefinite period. As regards public exhibitions, too, this Society performed a most useful function. Without in the least questioning the competency or good faith of exhibition juries, it was, nevertheless, he was sure, a fact that in the majority of cases the final awards were made in accordance with preconceived or prevalent opinions. To some extent, also, a society of this description supplied a want for the public telegraph service in our country which, in France, for example, is satisfied by the State itself.

Turning, then, to the work which lay before the Society, it was noticeable how small a part the application of electricity to naval and military purposes had played in their past proceedings. The importance of this branch of electrical engineering could scarcely be exaggerated, and it was being carefully studied by every civilised country. A certain reticence had hitherto prevailed among those who in this country could best enlighten us as to the offensive and defensive appliances which electricity had placed at the disposal of our Government, and we had to be content with the assurance that we were ahead of other countries in these respects. Perhaps this reserve was necessary, seeing that whatever might be said in that lecture room would reach the ears, so to speak, of every Government in Europe. But there was one point upon which our military electricians could safely enlighten us, namely, by bringing before the Society the particulars which constantly come under their notice of new appliances adopted by other countries. Colonel Webber then drew special attention to the subject of electrical physiology and the application of electricity in medicine and surgery, which had attracted much notice in France but very little in England. A case of treatment for diabetes recently made public in this country pointed to the value of direct electrical currents applied in some forms of disease, and showed that it was high time this Society took the subject in hand.

Referring to the recent Electrical Exhibition in Paris, Colonel Webber paid a warm tribute to the memory of Dr. Glösner, the manuscript evidence of whose knowledge and foresight was among the most startling and interesting of the exhibits. As far back as 1828 Dr. Glösner seems to have anticipated by prediction almost every application of which electricity has since been proved capable. The work of the Congress was then commented upon in eulogistic terms. An invitation to pass a resolution condemning the use of telegraph wires affixed to buildings was declined, the Congress wisely refusing to commit itself to a proposition which at present is in dispute, namely, whether the danger from lighting is increased or lessened by the multiplication of overhead wires in populous towns. A standard of electrical units was agreed upon, and the wire gauge was determined in millimetres. Committees were also formed to thoroughly investigate several most important subjects, such for example as earth currents, the supply of gutta-percha, the application of electric lighting, the fixing of some standard of photometric measurement, and the international protection of submarine cables. Reports upon these several subjects would be published in due course, and will, it may be confidently predicted, prove of immense service to electrical engineering. With respect to the last-named subject—submarine cables—Colonel Webber mentioned the startling contingency of a cable being laid along the coast of Germany southwards across all the existing cables connecting England with Europe.

Adverting again to the affairs of the Society, Colonel Webber thought that the change of title which, after careful discussion, had been adopted by the Society had resulted in some good; but he was by no means certain that the title chosen was the best possible one. As a matter of fact few people in this country describe themselves as electricians; and he himself was inclined to the opinion that "Electrical Engineers" was a title more in keeping both with actual facts and with the aims of the Society.

The concluding portion of the paper was occupied with the consideration of a scheme for extending the teaching functions of the Society beyond their present limits, and the establishment of something like a technical college in connection with it. The nucleus of such an institution already existed in the studentships assigned to the younger members, and this was capable of much further development. The demand for it was unmistakable, when the multiplication of callings requiring a thorough practical knowledge of the laws of electricity was now going on with unprecedented activity; and no existing institution could better supply that demand than the one over which they had done him the honour to call upon him to preside during the present year.

A brief discussion ensued.

ELECTRIC LIGHTING.

The Economy of Electric Lighting by Incandescence.

By John W. Howell, Student at the Stevens Institute of Technology.

(*Continued from page* 156.)

Test by Measurement of the Electromotive Force and Resistance.—In this test the electromotive force was measured between the binding posts of the generator, and the external resistance was measured between the same points.

The deflection and speed of the dynamometer were measured at the same time, the electromotive force was observed and the resistance was measured just before and after these observations, and was the same in both cases.

Data obtained from this test:—

Electromotive force, 53 volts.
Resistance of circuit (external), ·64 ohm.
Resistance between binding posts, ·629.
Average speed of dynamometer, 355 rev. per minute.
Average deflection, 42deg. (nat. sine, ·66913).
Total resistance of circuit, ·658.

Results obtained from these data:—

Energy developed in external circuit,

$$\frac{(53)^2}{\cdot 629} \times 44{\cdot}24 = 197567{\cdot}43 \text{ foot-pounds per minute.}$$

Total electrical energy,

$$197567{\cdot}43 \times \frac{\cdot 658}{\cdot 629} = 206673{\cdot}0295 \text{ foot-pounds per minute.}$$

Energy in armature,

$$206673{\cdot}029 \times \frac{\cdot 016}{\cdot 658} = 5025{\cdot}5.$$

Energy in magnet coils,

$$\frac{53^2}{37} \times 44{\cdot}24 = 3346{\cdot}667 \text{ foot pounds per minute.}$$

Energy in external circuit,

198300·88 foot-pounds per minute

Energy indicated by dynamometer,

·171·2 × ·66913 × 355 × 6·2832 = 2555 + 9·04 foot-pounds per minute.

Energy used in turning armature in field of force, 255519·04 × ·865 = 221023·97 foot-pounds per minute.

Energy actually applied to armature pulling 255519·04 × ·891 = 227667·47 foot-pounds per minute.

$$\text{Efficiency, } \frac{206673{\cdot}0295}{221023{\cdot}97} = 9{\cdot}35$$

$$\text{Commereial efficiency, } \frac{198300{\cdot}88}{227667{\cdot}47} = {\cdot}87$$

Average efficiency, ·951
Average commercial efficiency, ·887

Economy of the Conductors.—The economy of the conductors which convey the electricity from the generator to the lamps may be considered under two heads; first, the efficiency of the material; second, the efficiency of the dimensions.

The efficiency of any material is determined by its price and conductivity as compared with other materials. The two materials most commonly used for conductors are copper and iron. The present price of copper is about seven times the price of iron, and its conductivity is about six times as great; thus the actual cost of a line of copper wire of a given conductivity is one-sixth greater than an iron wire of the same conductivity. Copper wire, however, is much more uniform than iron wire, it is free from cinder streaks that are so common to iron wire, and is much more pliable and less bulky, and, therefore, less difficult to handle. For electric light mains which have to be frequently tapped, copper wire seems to be preferable to iron wire.

The Efficiency of Dimensions.—This is determined by the cost of the conductor and the loss of energy in the conductor. As the energy developed in different parts of the circuit varies directly as the resistance of these parts, some energy must appear in the conductors. This energy appears as heat and is lost. The most efficient dimensions of the conductors depends upon the amount of energy to be transmitted and the distance which it is to be transmitted. To secure maximum efficiency, therefore, we would have to calculate the most efficient size under all conditions as to number of lamps and distances. Knowing, however, the conditions most usually met in practice, we can determine that loss of energy in the conductors which is usually most efficient, and expressing this loss as a percentage of the total energy transmitted, calculate the size of our conductors upon this basis, by making the resistance of the conductors the same percentage of the total resistance of the circuit as the loss of energy allowed is of the total energy transmitted.

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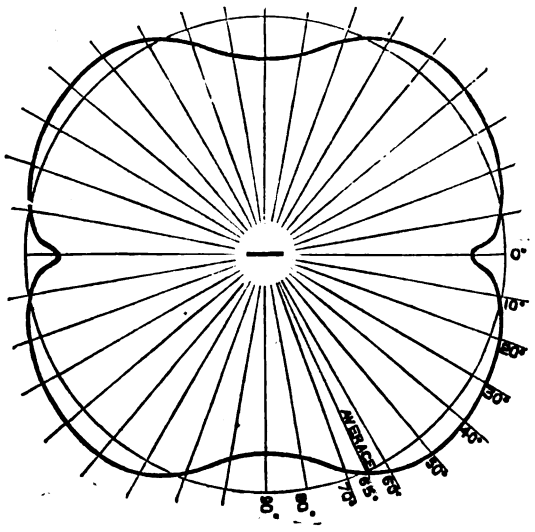
Thus, when we wish to calculate the dimensions of our conductors necessary to convey the current to a given number of lamps a given distance, allowing a loss of $\frac{1}{n}$ of the total energy, we must determine the resistance of our lamps and make the resistance of our conductors $\frac{1}{n-1}$ part of the resistance of the lamps.

Thus we see that the cost of the conductors necessary to carry the current for a given number of lamps a given distance, varies inversely as the resistance of the lamps; and altough we can make a high or a low resistance lamp of the same economy, it will cost less to convey the current to a given number of high resistance lamps a given distance, than it will to convey the current to the same number of low resistance lamps the same distance.

Economy of the Lamps.—The economy of the lamps is determined by the energy consumed and the amount of light produced in determining the energy consumed in the lamps, the electromotive force was measured between the terminals of the lamps, and also the resistance and energy determined in foot-pounds per minute by the formula $\frac{e^2}{R}$ 44·24. In measuring the electromotive force the same arrangements were used as in determining the electromotive force of the generator, but the damping magnet was adjusted to give three units of deflection to a volt instead of five. To measure the resistance of the lamps when burning, the current was divided into two parts; one part was passed through the lamp and the other through a variable resistance, when both were passed through a differential galvanometer, but in opposite directions; when the current was the same in both branches the needle of the galvanometer would indicate zero; as the electromotive force of the two branches was equal the current in the two branches would be equal when their resistances were equal, so by altering the variable resistance until the needle came to zero, and measuring the variable resistance, we thus determined the resistance of the lamp while it was burning. This variable resistance was measured each time before it cooled.

As the light given out in a horizontal plane varies at different angles, the angle of average illumination was first determined for the lamp used, which was the Edison lamp. To determine this angle the candle-power was measured every 10 degrees through a quadrant, and the candle-power observed laid off on a suitable scale on lines radiated from a point. A curve was drawn through the points thus determined, and the four quad-

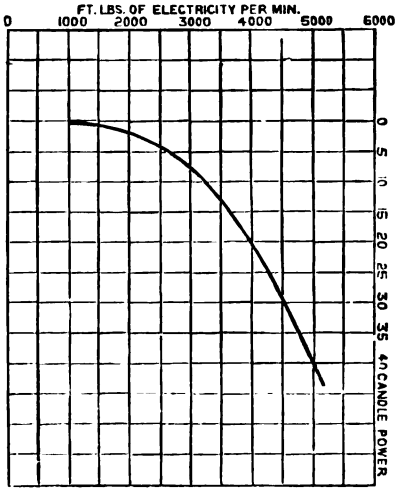


rants being made symmetrical its area was determined and a circle of equal area drawn about the point from which the lines radiate. The points where this circle cuts the curve determine the angle at which the candle-power is the same that it would be if the light were evenly distributed. Having determined the angular position of these points with reference to the plane of the carbon, all measurements were made with the photometer in this angle.

To insure that the lamp was in this position, it was twisted until the shadow of the carbon fell on the centre of the disc, and then turned through an angle of 65deg., which the curve shows to be the proper angle. All measurements of lamps were made at the angle of equal illumination.

In order to determine the economy of a lamp at different degrees of incandescence, an Edison lamp was measured at intensities ranging from a dull red to 40 candle-power, and the results plotted in a curve show a rapid rise in economy as the candle-power increases. While the economy of a lamp increases with incandescence, its life shortens, but as I have had neither time nor opportunities for life tests, I cannot give data for life at various degrees of incandescence.

Mr. Edison's standard of illumination has been 16 candle-



power, and his aim has been to produce a lamp that will give good economy and a reasonable life at that candle-power.

To determine the energy consumed by these lamps when burning at their normal candle power, five lamps, as made at present by Mr. Edison, were tested, with the following results:—

Table Showing Energy Consumed by Edison Lamps.

—	Candle-Power.	Volts.	Ohms.	Foot-Pounds of Electricity per Minute.
1	16	98·66	135·5	3178—03
2	16	98·66	142·5	3021—91
3	16	99·	140·5	3107—41
4	16	98	148·5	2861—15
5	16	99·33	131·5	3319—32

Showing an average of 3097 — 564 foot-pounds of electricity per minute, or 10·65 lamps per horse-power of electricity, giving 170 candles per horse-power.

Mr. Edison gets 10·65 lamps per horse-power of electricity, but as he allows a loss of 10 per cent. of the electrical energy used in the lamps upon the conductors he gets 9·68 lamps for each horse-power of electricity generated. As the average commercial efficiency of this generator is ·887, this gives him 8·58 lamps per dynamometrical horse-power.

The report of the Board of Commissioners of the Miller's Exhibition, held in Cincinnati just one year ago, gives the results of the trial of three modern steam engines. These results show an average for the three engines of ·8878 of the indicated power converted into useful work; using this factor for the conversion of dynamometrical into indicated horse-power we find that Mr. Edison gets 7·62 lamps per indicated horse-power.

ELECTRICITY *VERSUS* SMOKE.*

A year ago, in this place [the London Institution], I endeavoured to explain an intricate and refined discovery which had recently been made in the domain of pure theory, viz., the fact of the intimate relation existing between electricity and light.

To-night I am to speak to you on a subject involving no great discovery later than the time of Faraday, but on a subject which, from the point of view of practical application to the service of man, is of most intense interest and importance.

I have to point out to you, what doubtless you are all more or less aware of, that we are on the eve of a peaceful revolution, and that this revolution has even now begun.

The revolution I speak of is more than the change in the methods of lighting our houses and our streets which is obviously in progress, and which will, no doubt, gradually proceed till it has almost entirely displaced the method now in use. This will be

* A lecture delivered by Professor Oliver Lodge, partly at the London Institution and partly at St. George's Hall, Liverpool, in December, 1881.

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a great improvement. It will be quite as great, if not greater, than the change effected when oil and candles were superseded by gas.

But its main importance goes beyond this, for it will carry with it a no less important change in our methods of obtaining heat—heat for our houses, heat for cooking, and, I hope, also heat for manufacturing operations. And not only so, but another change, equally imminent and still more important if possible, will be effected, there can be no doubt, in our method of obtaining mechanical power. A triple revolution is what I have to speak to you of to-night—a revolution in lighting, a revolution in heating, and a revolution in work-performing or power-producing machinery.

That the modes of obtaining light, heat, and power now in use all over the world are likely to be thoroughly reorganised is not a rash prediction founded on probabilities, but is a simple deduction, plain to any one who has familiarised himself with the course of recent scientific progress, and not likely to be opposed by a single scientific objector.

At any rate, I make the statement here to-night in no rash or speculative spirit, but because I believe it to be the universal opinion of practical and scientific men, and because I welcome it as one of the most hopeful and important and beneficent contributions to practical life that science has made since it gave us the electric telegraph. We of this generation have witnessed the introduction of the telegraph, and of its perfection in the telephone. I trust that we may live to see a great portion of the impending still more stupendous improvement introduced by electricity. What I want to do this evening is to bring rapidly before you the various processes and devices which are now known theoretically, but which are in their early stage only of practical application, so that you may judge for yourselves whether what I have said is at all an exaggeration, or whether it is not, as nearly as one can judge of things not yet accomplished, the probable truth. And then I also want to point out why it is that we should hail the introduction of these processes and devices into our daily life with the greatest hope and enthusiasm as a means of indefinitely benefiting the human race.

The epoch at whose close we are now arriving has been called the age of coal. The epoch on which we are entering has been recently named, in advance, the age of electricity. These names I propose to modify a little. I would not by any means imply that the age of coal is over. It never will be over till the coalfields are practically exhausted. The age out of which we are beginning to emerge I should prefer to call, therefore, the age of smoke. The epoch we are entering on I would call, not that of electricity only, but of electricity and gas. Yes, while the employment of electricity is as yet in its infancy, the employment of gas is, I believe, still young, and a splendid maturity lies before it. If you will permit me to re-christen this lecture, I will do so by calling it "Electricity and Gas *versus* Smoke."

Electricity is not going to supersede gas any more than it is going to supersede coal. What is, I hope and trust, going to be superseded by gas and electricity together is that abominable nuisance, smoke.

I do not want to waste time, but I must just try and excite in your minds something of the disgust and detestation which I feel at the present smoky condition of all inhabited towns. Never were towns so large; never was so much crude coal burnt, and, consequently, never in the history of the world was the atmosphere so unbearably polluted. And yet large towns are a necessity. The tendency to centralisation must continue, people must live together in cities, but something must be done to leave the air of those cities in a state fit for them to breathe. The size of London is becoming perfectly appalling, and the atmosphere of London is steadily deteriorating, and last winter it was like nothing so much as that of the underground railway. I want people to exert themselves, and to agitate for something to be done to put a check to all this. If not, it will assuredly only get worse. The air of the underground railway is really not fit to breathe at times. I do not believe people would stand it only that the air outside is so bad that they get accustomed to it and take it as if it were inevitable. But it is not inevitable, and compressed air is the proper remedy for that. If the locomotives were driven by compressed air instead of by steam there would be no sulphurous gases, no choke damp, no oppressive heat, no solid particles clogging up the pores of one's lungs; but instead a magnificent automatic system of ventilation which might make the air down there as good as any in London.*

* I know that it has been attempted to knock this plan on the head by calculating the area of City land required to construct the requisite pumping station at Moorgate-street or Mansion House. But who would think of putting down gigantic works like these in the heart of the City? There is open ground near Gloucester-road and Earl's Court; and, if that is not enough, the expanse between Wormwood Scrubbs and Shepherd's Bush is not so far from High-street, Kensington, as to make it absurd to think of laying down pipes. When the City circuit is completed, one place will be as good as another for feeding; and, with good local reservoirs and fairly open pipes, it need not be a long process.

However, that is a digression, though an important one. What I am more concerned with now is the smoke in the atmosphere at large. If any one asserts that smoke is not unhealthy, let him think how he would like a few dozen factory chimneys turned on while he was enjoying his summer rustication at Malvern, or the Highlands, or the seaside. Let him think of its effect on vegetation, the pores of whose breathing organs, the leaves, it chokes up much as it does those of animals. Smoke is not unhealthy in the sense that sewer gas is unhealthy; things that kill people off I would not call *unhealthy*, but *poisonous*. You don't call arsenic "unhealthy." Smoke allows people to live, I grant, but it almost makes their life not worth living. Why do townspeople have pallid, blanched faces, and country people fresh and rosy, or bronzed ones. This is why, because the smoke absorbs the actinic rays of the sun. It is these rays that bronze one and that invigorate vegetation. A pall of smoke cuts them off, and it is well known that industries that depend on them cannot go on in towns. The wax bleaching processes recede year after year further and further from the metropolis. The sun has scarcely any chemical power, owing to the smoke. London is reasonably healthy, not because it is smoky, but because it is well drained. It is this circumstance which gives towns an advantage over the country; but give them fresh air too, and they will be the healthiest and pleasantest places to live in. At present, the only places where you can get pure air to breathe are just those places where there are no people to breathe it. This is an anomaly. I could be certain that no one would be blind to the evil of the smoke nuisance, were it not that habit accustoms us to a thing, and makes us regard it as unavoidable; and were it not, also, for a wholesome feeling that, when an unpleasant condition is inevitable, it is best accepted in a philanthropic spirit, and endured as far as may be in unconscious resignation. This, I say, is wholesome as long as a thing is felt to be inevitable; but it is precisely because I see that it is not inevitable that I am preaching here to-day, and I want you to perceive clearly that it is not inevitable too, but that it is remediable, and that it ought to be remedied.

(TO BE CONTINUED.)

CORRESPONDENCE.

SUTTON'S SECONDARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Much has recently been said and written about several secondary cells which have been experimentally tested by Mr. Henry Sutton, of Ballarat, Victoria, and which have doubtless been tried, and given up, by many other electricians. In regard to the copper-lead arrangement, it may be said that it constitutes a perfect secondary battery *except in one particular*; but the deficiency is fatal to its chances of successful competition with such batteries as those of Planté and Faure. It works permanently, with perfect regularity, and with the minimum amount of waste in charging, little or no hydrogen being evolved. But the electromotive force of the couple recommended by Mr. Sutton is only 62·5 per cent. of that developed by the other batteries just mentioned. Of two things one:—Those who write and speak so glibly of the advantages offered by the Sutton cell are ignorant either of this fact or of the great commercial importance of even a small difference in the working electromotive forces developed in secondary arrangements. They would appear, also, to be scarcely in a position to judge as to the point of novelty.

It should be well understood by all who write or speak on the subject of secondary batteries that, whilst on the one hand nothing has yet been found to equal *lead* as the anode in such arrangements, we cannot, on the other hand, with our present knowledge, use for the cathode a metal either electro-negative or electro-positive to lead without loss—in the one case of the energy stored in hydrogen wasted during the process of charging, in the other case of electromotive force, the loss here being due to the inversion of the ordinary relation of the metals in a voltaic cell. Were it not for the facts that hydrogen is necessarily evolved when a metal, such as zinc, electro-positive to hydrogen, is employed as a cathode in an aqueous electrolyte; and, secondly, that no means have yet been devised for effectively utilising such hydrogen, some of the old secondary arrangements, such as Cromwell Varley's zinc-mercury cell, might be rendered very effective. And were it not for the fact that we cannot replace by copper the more oxidisable metal lead (of which the electro-positive character would be more generally recognised and utilised if it had not the property—so valuable in the con-

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struction of secondary cells—of forming with sulphuric acid a radical compound insoluble in water) without a very great loss of E.M.F., the arrangement most favoured by Mr. Sutton would, no doubt, be of some practical value.

The discovery of the advantage of amalgamating one or both the electrodes is actually of some practical value, but in this discovery I imagine Mr. Sutton has been anticipated.—Yours, &c., DESMOND G. FITZGERALD.

PNEUMATIC CLOCKS IN PARIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having observed Mr. Berley's remarks in his letter, inserted in your valuable journal of the 7th inst., I beg leave to say that Mr. Berley is wrong in stating that Mayrhofer's system of pneumatic clocks has not been working for some time past in Vienna and Paris.

I herewith send you papers which clearly show that the Popp and Resch system is no other than the original invention of Mr. Mayrhofer.

In consequence of legal proceedings now pending, neither of the parties have at present any just right to work the system in question. This refers to Mr. Mayrhofer's old system, on which he has since made considerable improvements, and taken out new patents, which we term "Mayrhofer's new system of electro-hydro pneumatic clocks," the principle of which has likewise been exhibited and worked in Vienna, and at the Electrical Exhibition recently held at Paris, and also at Place de la Bastille by the Society of Engineers at Paris.

The statement in your issue of the 31st of December last is, therefore, quite correct.—Yours, &c.,

London, January 25, 1882. L. A. GROTH.

THE ELECTRIC LIGHT IN ZANZIBAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: So much interest is felt in the all-absorbing topic electric lighting that I am sure an announcement to the effect that His Highness the Sultan of Zanzibar has introduced it in his capital will be read with gratification.

On the summit of his tower—a structure about 250 feet high—His Highness had a revolving light which could be seen by vessels a long distance off. This boon to mariners was on the 30th November last superseded by the infinitely better electric light which, although as yet worked only by a temporary engine, gives very satisfactory results. The proper engine has not arrived. With the dynamo machine accomplishing its specified speed of 600 revolutions per minute, and the engine working steadily, the lamp gives a brilliant light which enables us to see half way down the black people's throats as they stand and stare with mouths wide open and faces bearing the stamp of the utmost amazement and wonder. The palace square below is splendidly lighted, and one can read small print there with ease. The ordinary oil lamps burning round about the Sultan's palace and the square sink into extreme insignificance beneath the sunlike brilliancy of the electric light, and they all look wretchedly dull and yellow, as if they were suffering from jaundice.

His Highness is very pleased with this, his latest importation from England, and promises in time to turn night into day in Zanzibar by means of the electric light.

The dynamo machine and lamp were made by Siemens Brothers. The light equals 3,000 candles. The engine and machine are fixed at the base of the tower.—Yours, &c.,

December 13, 1881. D.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Professor Sylvanus P. Thompson objected to electricity being matter because it did not possess the property of gravitation, when I urged that it was a particular kind of matter because it possessed the power of attraction for its own particles, although it did not possess the property of gravitation. In reference to this, I desire to lay before the readers of *The Electrician* the following extracts from Professor Tait's "Sketch of Thermodynamics," second edition, 1877, page 74:—"All motions of air, whether sounds or winds, therefore, are ultimately transformed into heat, and thus dissipated and lost, though not destroyed. Whether there is anything analogous to this in the case of the undulatory motions of the inter-planetary ether is a grand, but as yet almost entirely unattempted, inquiry. But in actual experience the results of even the simplest theoretical cases of abstract dynamics are never realised. For, besides the friction between solids and the viscosity of fluids just considered, every motion of matter is resisted by the all-pervading ether."

Here Professor Tait draws a contrast between common matter and that which for more than one century has been, by scientific men, called the inter-planetary ether. In my letter published in the *Greenock Advertiser* of 1839, already referred to in your pages (Vol. V., p. 268), I gave it as my opinion that electricity is the inter-planetary ether. Let us see how this opinion accords with the more recent discoveries and calculations regarding the ether. In Professor Tait's work above quoted, page 90, he writes:—"Sir William Thomson has shown that to account for the transmission of light and heat from the sun we must admit that the inter-planetary medium has a density by no means inappreciable." Professor Tait, after giving some speculations of Clerk Maxwell, which he ultimately abandoned, adds: "Clerk Maxwell seems, however, to have since discarded these hypotheses, and to rely only on the principle of energy applied to investigate the properties of the medium which he supposes to be the cause of electro-magnetic effect. He assumes that there is a medium capable of transmitting light and heat, and therefore capable of storing up two kinds of energy—that of motion and that of elastic resilience—both which are exemplified in the case of luminous waves. The medium, if capable of these motions and stresses, may also be capable of others, and these may produce visible phenomena." At page 103 Professor Tait writes:—"The sun, however, has been calculated to give out energy so profusely that the radiation from one square foot of its surface amounts to 7,000 horse-power. This estimate is probably too low, as no account is taken of possible absorption by the matter which fills all space between the earth and sun." According to these quotations the advance science has made may be estimated by the statement about Sir William Thomson's calculations, which led him to say that the inter-planetary medium has a density by no means inappreciable, and Professor Tait's statement that the inter-planetary medium must be matter. The question arises, what kind of matter can this be? If it be matter which is subject to the law of gravitation the space between the sun and the earth would long ago have been emptied of that matter by the earth and the sun's attraction of gravitation, and the transmission of light and heat from the sun to the earth would have been stopped; but since this latter result has not taken place it is obvious that the inter-planetary matter must be of a kind which is not subject to the law of gravitation. Now, we have no experience of any kind of matter which is not subject to the law of gravitation, except electricity, which I have shown must be a kind of matter, because it possesses attraction for its own particles, for proof of which see my previous communication to you (p. 141), where I have shown that the electric spark, or thunderbolt, is formed by electricity's attraction for its own particles. If it be replied that this amount of attraction must be such that, if the space between the sun and the earth is occupied by electricity, it would have long ago united together by its own attraction, and left the space void, I reply, No, what we see of electricity running together by the attraction of its own particles in the form of the spark or thunderbolt occurs near the earth's surface, under the pressure of the earth's atmosphere; but we have proof of a different state of matters in the higher regions of the earth's atmosphere. There, when electricity moves in masses from one part of the upper atmosphere to another part of it, no thunderbolt appears. We see only that diffuse form of electricity which has been called sheet-lightning, and from this diffused state of electricity in the upper regions of the earth's atmosphere it is reasonable to conclude that beyond the earth's atmosphere electricity will occupy the whole space undisturbed, and is the medium by which heat and light are transmitted from the sun to the earth.—Yours, &c., JAMES JOHNSTONE.

Experiment Rooms, 1, James's-square, Edinburgh,
14th January, 1882.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

The first annual meeting of the shareholders of this Company was held at the Cannon-street Hotel, E.C., on the 25th inst., under the presidency of Sir Henry W. Tyler, the Chairman of the Company.

The SECRETARY (Mr. Wm. J. Cordner) having read the notice convening the meeting, the report of the directors was taken as read.

The CHAIRMAN then said: It is with great satisfaction that we have the pleasure of meeting you at the end of our first year of working in this Corporation. You are aware that we started in December, 1880, and therefore we have been just a year at work. During that year we have had, as you may imagine with a new business of this description, very many difficulties to contend with. We have had to organise machinery for manufacturing what we sell, we have had to organise a staff for the working, and we have also had to organise a staff for the installation and putting up our lights in different parts of the country, and any one who knows what it is to collect together appropriate machinery of a new description for a new manufacture will be able to appreciate something of what we have gone through. We have chosen the earliest possible time to meet you, and, on this subject,

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I would just observe that, before the middle of last year there were one or two gentlemen who were very anxious then to have a meeting, and very anxious then to have immediate accounts of the Corporation. Our Articles provide that our meetings shall be annual, and that was one good reason for not having a meeting, as those gentlemen proposed, in the middle of last year; but, further, it would have been most unfair to the Company, and to the shareholders, to have had the meeting earlier, to have stopped the staff. to have taken stock, and to have tried to render accounts for a thing only working six months, for during that time it was impossible to have made any progress that would have been satisfactory to you or to us. Now, I think what we have done in twelve months is really most gratifying. As you will have seen by the accounts we have really returned to you, we may say, in one sense, more than half the whole capital of the Company during the twelve months. I am not going to enter into full particulars as to those accounts. I have heard it observed that our report is rather short, and that our accounts are rather concise. Well, we have made them so on purpose for this very good reason—that we have a great many rivals in the field, and they would be very glad indeed to know a little more of what we are doing. We have a great many negotiations going on in other countries. We have sold some patent rights, licenses and concessions in this country; but we have other patents under negotiation for other countries as well as other counties in England, and it would very much embarrass us in these negotiations were we to tell you in detail what we have done with regard to each country, or each county in this country, and, therefore, I will ask you to excuse me for doing what I and every member of the board would be glad to do if it were to the interest of the Company—that is, to tell you all our secrets and the details of our operations. The net profit, by the accounts, for the year, has been £134,965, and of that amount £99,500 in cash and shares has been derived from the sale of patent rights, concessions, and licenses, while £35,465 has been derived from our manufactures. We laid down this principle—and I think you will all agree in it—that whatever, on a review of the accounts, was fairly derivable from the profits of manufacture we should divide in dividend, and that whatever came to us from the sale of patent rights and concessions we should put to reserve fund. I think that that is a sound principle to go on, as in a business of this description we don't know what may happen in the future, what new inventions or new principles may be brought forward; and I think, as time goes on and we continue to prosper, as I hope, it may be wise in us to reduce our present capital, and so make it more easy in future to earn dividends on the capital we shall retain. Of that £99,500, which we have received in cash and shares, about half is in cash and half in shares. The shares are in only three companies, and, of course, I cannot pretend to estimate what may be the value of those shares in the future. We have taken them at par value, and we could not put any other value on them at present; but I apprehend that we shall not be far wrong, for if the shares of one company a year hence may be under par, the shares of the others may be above par. I hope that that is not very far from their actual value at present—putting the par value on the whole of them. You will observe that we have nothing left to charge in any future year as regards preliminary expenses or expenses of that description. That is all wiped out, and we have also written off—although, perhaps, it was hardly necessary to do so with new machinery—at the rate of 10 per cent. for depreciation of plant and machinery. We shall propose to continue that in future years, so that in ten years the plant will have paid for itself. In the course of beginning our operations, it was with doubting minds that we went to inspect some premises in Belvedere-road, Lambeth. There is there a large building, or rather there are two large buildings, one of them having three floors, each 100ft. long by 47ft. wide, the other having three floors, all 60ft. long by 37ft. 6in. wide, and another large building, besides a good yard. They are capital premises altogether. Well, we went there with doubting minds to see whether that building was not too large, and whether we were justified in going to the expense of taking them to begin our manufactures. We were not long, however, in fully employing those premises, where we have eighty-five lathes, thirty-five drilling and other machines, and twelve milling machines. The place has been almost blocked up with our manufactures; and we are now erecting a fresh building in the yard for a new testing room. The first thing we supplied in the way of engine power was an engine of 120 horse-power, and we are now putting up two new engines of 150 horse-power. We have not only completely occupied that building, but have acquired some very excellent offices adjoining, and we have overflowed from that building till we have now two other factories. Our profits have been made out of this first building at present; but we are looking not to the present moment, but to the future of electric lighting. In addition, therefore, to the Brush system of dynamo machines and lamps we have acquired the patents of Mr. Lane-Fox, whom we believe to possess by far the best system of incandescent lighting, and the best patents connected with incandescent lighting, and we have taken a special factory for the manufacture of incandescent lamps and manufactures in connection with it in Portpool-lane, not far from our former offices, in Hatton-garden. There we have three floors 100 feet long by 70 feet wide, and we are putting up an engine of 150 horse-power there, in addition to smaller engines. At those places we now employ 332 men at Belvedere-road and 124 men at Portpool-lane. Thus, altogether, 456 men are employed at manufacturing, but before long—our system is developing so rapidly, and we have now £46,000 of orders on hand—we expect to have 1,000 men fully employed. Not only so, but finding that the works I have mentioned would be insufficient for our purposes, we have taken another building, larger than both the others together, in the Borough-road. There is a large building of five floors, 240 feet long by 40 feet wide. We have already two engines there of 80 horse-power, and we shall be obliged to provide extra machinery. Therefore, although we began in a cautious manner and have carefully felt our way, we have by degrees got into a very large manufacture. We have considered very much the question of central lighting, and what we should do in undertaking the lighting of towns and other matters of that sort; and we have felt that it was hardly for the parent company to undertake all this business. It would require very large capital indeed and an enormous staff, and would require more superintendence than could be conducted by any one company of this description. We therefore have thought rather to sell our concessions for different counties in England, and to induce other companies to undertake this detailed business, so that we may have local influence brought to our advantage, and the value of the services of a great many gentlemen. We believe that in that manner, by so employing other people—who we hope may also gain large profits—we shall best be able to make the largest profit ourselves, so that by-and-bye we shall become the manufacturing centre for a large number of affiliated companies in England, Ireland, and Scotland, and various parts of the Continent. We shall be very happy to supply them with all the machinery they may require, and to make all the profit we can out of that. We have been obliged to spend some money which brings in no direct return—such as in connection with exhibitions. We had a very fine display at the Paris Exhibition, which did us great credit, and which has been conducive to extending our system at Paris. The great opera house has already been lighted up with our light successfully. We have been obliged to spend a great deal of money there, and we are spending a great deal at the Crystal Palace. I begrudge money so spent, because it brings in no return, but it does not do for us altogether to fall in the background; and I am sure that you would wish us to do all that we can to extend our operations. But we do not indulge in those other extravagances which some rival companies do in undertaking to do a great deal of work without being paid for it, or in lighting up houses of certain influential people for nothing with the expectation of getting something indirectly. We conduct our business on strict business habits, on strict business principles, and even if our directors want anything out of our works they have to pay for it. That, I think, is the proper way to conduct a company, and not to throw away money on people who may never give you any return for it, and, at all events, not to spend money, as far as you can help it, without getting a proper return. To show you that our Brush system is really an assured success, I may mention the number of machines and lamps sold up to the present time. In England we have sold 220 dynamo machines and 2,711 arc lamps, but in the United States, where they have been longer at work, where coal is dearer, and where there is more opening for rapid development for such a system, we have sold 850 machines and 12,457 arc lamps. I believe that 10,000 of those have been sold during the past year. We are sometimes told that the arc light is going out of fashion, and that the incandescent light is to take its place; but if 10,000 arc lights have been sold during the past year, I think that there is a good deal to be done in the same direction in other countries besides America. Arc lighting is more adapted for open spaces, streets, factories, and for large manufactories of all descriptions, while incandescent lighting is more adapted for domestic purposes, theatres, clubs, and buildings of that description, and I believe there is a great future for both of them. As regards failures, some of you, perhaps, have met with some of our lamps which have not burnt as well as they might, and as our others burn, or which have been put in certain places where they have not been such a success as in other places. I do not think it is wise to try and hide this, because the causes of our failures have been very simple indeed—chiefly because we have not, in sending people all over the country, been able in the first instance to get as many people of the best description to do the work as we could desire. It is very difficult in an affair of this sort to get a good staff of men to work efficiently. That has been one of the principal causes of our failures—that these men have not been able to put down properly all our connections, and we ourselves, not thoroughly knowing our business, have not been able to make all our connections right—for instance, in the City, where, through a defect, we had to do some work over again. In any new business of this sort you must learn by your failures, and instead of hiding them it is better to show the causes of them. When we know and can point out the reason of every failure we have had—and they have been only a few altogether—you know that it is not the system that has failed, but the application of it; and we have had great success, I may say, in manufacturing our machines and lamps. Contrary to what we were told when we began, we have had wonderfully few failures. The lamps and dynamo machines turned out in the Belvedere-road have succeeded, considering that it was a new manufacture, wonderfully well, and the wear and tear of this apparatus is very little indeed. The wear and tear of a dynamo machine is scarcely anything as compared with other machines and lamps, and some will do better at the end of twelve months than when first put up. We have heard from time to time about the danger of the electric light. Now, I don't want to blink what the dangers are. There are dangers. There was a man killed, most unfortunately, at Hatfield House, and one of our machines was the culprit. It was not, however, done by ourselves. We were not concerned in the installation at Hatfield House. We were asked to lend a machine, which we did, but the people who borrowed the machine did not take the trouble to use wires properly covered, but naked wires, and the poor fellow put his hand on them and was killed. There is, however, no occasion to apply naked wires to a garden wall. There is danger in anything else you may use. Then, again, the wires require to be properly insulated in houses. It is necessary that they should be put down in a careful manner, but the precautions to be taken in that respect are most simple—perfectly well known—and if adopted there is no danger whatever in electric lighting. When, too, you compare electric with other descriptions of lighting—with candles, petroleum, or gas—you may say that electric lighting becomes a perfectly safe system. Look at the danger of candles from servants carrying them about a house, dropping grease everywhere, and leaving matches about, and from young ladies dressing for a ball or the opera, catching their sleeves in the light. Take petroleum, again. What is more fearfully dangerous than the use of petroleum, paraffin, or kerosene, or any other of those mineral oils? If any happens to fall on the floor and a light catches it the house is burned down. The greatest conflagration the world has ever seen, in Chicago, when the whole city was burnt down, was through a petroleum lamp upsetting. So with gas, it is most dangerous. Every day almost you hear of its dangers. So common are they that you do not take any notice of them. Only a day or two ago in the *Globe* we heard of a serious gas explosion at a private house at East Dulwich. Having read the account of this explosion, he continued: We all know, too, that when a certain proportion of gas is mixed with a certain proportion of air, if a light is brought into the room a fearful explosion occurs. A few days ago in the *St. James's Gazette* there was an account which began as follows:—"Gas explosions seem following each other with alarming rapidity." After reading the extract, he continued: I might multiply these instances, and anyone who talks about the dangers of electric lighting should look a little to what the dangers of other kinds of lighting are.

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I was very much pleased at seeing the effect of the electric light in the fog. It was the first opportunity we have had for seeing our electric light in a real London fog, such as yesterday. I went to see the different systems in that fog, and I was very much pleased with the results of our lights in that fog. The effect of the fog was almost obviated, and comparing ours with other systems in the City, looking at the height of our lamps and the light they afford, I thought we did not compare unfavourably with the other two systems. I was, however, most of all pleased the other day when I went down to South Wales. I happen to be the chairman of the Rhymney Iron Company—an important Company there; and I was exceedingly pleased with my visit. When I went round the works at night, as is my habit, first the general manager came and told me that our electric light was really beautiful, that the men were working just as well by night as by day, and were able to carry out operations which previously they could only do in the day. In fact, our light has saved that Company a great deal of money, for otherwise they would have had to duplicate their machinery for the purpose of those operations. Not only did the general manager speak in this manner of our light, but the agent of the rolling mill said the same thing, and further stated that its introduction was the greatest blessing. I hope if any gentleman is present who is interested in any ironworks he will consider whether the Company may not be useful there also. We lay claim, and I think justly, to having the best system of arc lighting and the best system of incandescent lighting, and, whatever other discoveries are made or brought forward—we intend to keep in the van, and to keep ahead of all other systems and companies. I have told you a little of the difficulties we have overcome at the outset, and I believe that those difficulties have been so formidable that other companies have not been able to succeed as well as we have—in fact I have not heard of any other company that has made any profit at all in this business, while we have made very considerable profit. I do not want people to be misled, and to suppose that because we have made this profit (and we have been fortunate in many ways, and have had the best systems) that, therefore, they should go and buy the shares of other electric light companies. I have known people ruined in acting in such a way as that in connection with companies of another kind. In the same way the success of this Company must be no criterion as to what other companies of a similar character are going to do. You may depend on it that all the attention we can give to this business we shall give, and we shall do our best to give you as good a return for the second year of our existence as we have done for the first. He concluded by moving the usual resolution for the adoption of the report and accounts.

The DEPUTY CHAIRMAN (Mr. John Scudamore Sellon): I cannot pretend to address you with the ready speech which our chairman posseses, but I do rise with great pleasure to congratulate you on the success of the undertaking of this work, it having been one of the most unique and novel character. I associated myself with it as a great enthusiast of electric lighting generally, and afterwards as a special enthusiast of the Brush system, because after, I may almost say, some critical examination of others, I felt that there were in the Brush system elements of success which I could not see in others, inasmuch as there were an economy of working, and safety in working, and good results in lighting which I could not see in any other system. I think I may repeat what our chairman has said, that we are justified in believing that we do possess the most complete system of electric lighting—certainly the best dynamo machine and the best arc light, and we have every reason to believe, from its surroundings and principles of distribution and regulation, the best system of incandescent lighting. Our opponents may call in question our judgment in this matter, but I can only use the old saying, let "the proof of the pudding be its taste," or let the proof of good quality be its success. The fact cannot be disputed, that with the introduction of the Brush system in England electric lighting received a great impetus. Before that it was almost a dead letter. A little, very slow and creepy, progress had been made, but at a cost, and with other difficulties, which made great extension impossible. We certainly think, also, that we should receive the thanks of the public in having "brushed up" the gas companies of London. They wielded a great power in virtue of their monopoly, and that power was certainly wielded with tyranny and want of consideration for the requirements of the public, whereas they will now have to look to their p's and q's, and probably will have to give a better light at a lower price—in fact, have to serve their customers instead of being their masters. As to the efficiency of the Brush system we have had great difficulties to contend with, and great influences have been brought to bear against us. We have had to put up with many foolish—I may almost say malignantly untrue statements that have appeared in the papers, some of them so-called scientific papers; yet in spite of all we have steadily made our way to unparalleled success. We have avoided useless controversies, and meantime—while not pretending it is infallible—our system above all has secured the confidence of those whom we care about—those who will buy and pay for our apparatus. We have had to gain experience, and this has been one of our most difficult points; but time must be given to educating our staff in the work. I will, however, venture to say this—that few starts have ever been made in any business with fewer failures than we have had. So much has been said of every little failure of the Brush system that I may say that it shows that the eyes of the world have been on us. If you look to analogous works—such as marine or land telegraphy, or the telephone—you must know, particularly those who have investments in them, that much of the work done has had to be redone at immense cost, but we have not had to do much work over again at severe loss. It was said that we made a great loss in the City in having to draw out the old cables and put in new cables; but I think £10 would have covered that loss. The work took a few men a very short time to do; and the old cables were just as valuable to us, and as available for other purposes as they were at first. It has been quite amusing to see the record of every little failing during what I may call the novitiate of the Brush system. Other systems may fail, and no notice is taken; but if the Brush light goes out, the town is at once placarded with "Failure of the Brush System." That was recently the case in a town where the Brush light went out, and through some mistake it could not be lighted again for twenty minutes. The next day some of these placards were posted throughout the city announcing the failure of the Brush system. That shows how all eyes are on us, and how necessary it is to maintain the position which this criticism proves we have gained. It does us good to have our eyes opened to any little failure. Quite recently an article appeared in one paper, headed "Unscientific Electric Lighting," but it was simply a diatribe on the Brush system, on the strength of the wires for the Edinburgh lighting having been suspended from lamp to lamp. I was asked how we could do such a foolish thing. Well, it was unscientific, and no one would think of putting up wires permanently without installation, but these wires were put up for a temporary purpose for three months, and we do not care, as the chairman intimated, to waste our money. It was quite understood when the experiment was undertaken that it was a temporary thing, and it was put up in great haste to be in time for the Queen's visit to Edinburgh. Many of the papers wrote about it, and laid great stress on the folly of the Brush people undertaking such work. Fair criticism we do not complain of—in fact, we rather court it, but what we do complain of is when criticism—under the guise, too, of scientific criticism—is made without want of knowledge of the case, or imperfect knowledge of the circumstances. I believe you possess in your various patents and in your manufactures systems and properties which cannot be excelled, and with the extension of our factories facilities for work which cannot be equalled in any way; and that if electric lighting is to become the great development which we may all fairly anticipate (the neck of the opposition is certainly broken), we have a very fair prospect, and we are all shareholders, of being first in making more rapid, if not the most rapid, progress, and of receiving, we may hope, a continuance, and long continuance, of satisfactory results. I second the motion.

Mr. WILLIAM ABBOTT thought, in face of the satisfactory report presented, showing the great strength of the Company, they need not have any anxiety as to unfair criticisms. It was said, truly, "Nothing succeeds like success," and the success of the Company had been so marked that he thought in future they could command the situation. He then inquired in what way the connection of the Company continued with the Hammond Company.

Major LESLIE alluded to the chairman's remark that part of the capital of the Company might be refunded, and, as it would be a loss to the shareholders should the capital be returned at par, he wished to know whether the return would be made on the shares which were £10 fully paid, or those on which £4 had been paid up.

The CHAIRMAN, in reply to Major Leslie, stated that no scheme was before them, and it was merely an idea at present that it might be wise in the future to return some of their capital, for the reason he had mentioned. Hammond and Co. was an independent company affiliated to theirs, but they hoped that its connection with the parent company would be most intimate and profitable to both.

The report was then carried unanimously.

Mr. Charles Dorman was elected a director in the place of Mr. T. J. Montgomery, and Mr. Nettlefold and Mr. Bullivant were re-elected, the Chairman congratulating them on their success in having induced Mr. Nettlefold to continue a director—at all events for the present.

Mr. A. E. Jarvis was re-appointed an auditor, and

On the motion of Mr. W. ABBOTT a vote of thanks to the chairman and directors brought the proceedings to a close.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES JAN. 25.		BUSINESS DONE WEEK ENDING JAN. 25. Highest.	Lowest.
Anglo-American	48½	49½	49½	48½
Do. Preferred	76½	77	78½	76½
Do. Deferred	20¼	21	21¼	20¼
Brazil Submarine	11½	11¾	11¾	11½
Cuba	9	9¼	9¼	9¼
Do. Preference	16½	17½	—	—
Direct Spanish	5	5¼	—	—
Do. Preference	14½	15½	—	—
Direct United States Cable	10½	10¾	10¾	10¾
Eastern Telegraph	9¾	10¼	10¼	9 15-16
Do. 6 per Cent. Preference	12½	12¾	—	—
Do. 5 per Cent. Debentures, 1899	105	108	105	106
Eastern Extension	10¾	10¾	11	10¾
German Union	9½	10	9 15-16	9¾
Globe Telegraph and Trust Company	6	6½	6 5-16	6¼
Do. Preference	12½	12¾	12¾	12¾
Great Northern	10¾	11¼	11¼	11¼
Indo-European	28	29	28¾	28¾
Mediterranean Extension	2½	2¾	—	—
Do. Preference	9¼	9½	—	—
Reuter's	12½	12¾	—	—
Submarine	285	295	—	—
West India and Panama	1½	2	1 15-16	1 15-16
Do. 1st Preference	7½	8¼	8	7¾
Western Brazilian	7½	8¼	8 1-16	7¾
West. Union 7 per Cent. 1st Mortgage	123	128	—	—
Do. 6 per Cent. Sterling Bonds	104	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼	1¼	1¼	1¼
Oriental	⅛	¼	—	—

ELECTRIC LIGHT.

Electric Light and Power	1	1¼	1¼	1 3-16
Anglo-American Brush	9	9¼	9¼	9 3-16
United Telephone	11½	11¾	12¼	11¾

TRAFFIC RECEIPTS FOR DECEMBER, 1881.

COMPANIES.	Dec., 1881.	Dec., 1880.	Increase.	Decrease.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	£2,500	£2,494	£8	—
Direct Spanish Telegraph Company	1,459	1,520	—	£61
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,319	28,010	3,309	—
Eastern Telegraph Company	49,844	46,776	3,068	—
Great Northern Telegraph Company	16,720	—	—	—
Submarine Telegraph Company	—	—	—	—

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SLIP

ELECTRIC CLOCKS.—A system of clocks regulated by electricity is being introduced into Genoa.

THE MAGAZINES.—This month's *Modern Thought* contains an article on the phonograph and its relation to sound and the ear.

ELECTRIC LIGHTING IN BERLIN.—The Town Hall of Berlin is to be lighted by electricity. Messrs. Siemens have the work in hand.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY. — The traffic receipts of this company for the week ended 27th ult., amounted to £3,946.

THE ROYAL ENGINEERS TELEGRAPH TRAIN.—The second company or telegraph train of Royal Engineers left Natal on January 26 for England.

ELECTRIC LIGHT IN BERLIN.—Messrs. Siemens and Halske have contracted to light some of the principal streets in Berlin with their lamps.

AN AUSTRALIAN ELECTRIC LIGHT COMPANY.—The formation of the South Australian Electric Light and Power Company is announced from that colony.

NEW ELECTRIC LIGHT COMPANY.—The Electric Light Construction, Supply, and Maintenance Corporation has been formed, with a capital of £500,000, in £5 shares.

THE TELEPHONE IN PARIS.—A telephone station has been formed in the Chamber of Deputies in Paris, and is to be placed at the sole disposal of members of the Chamber.

EASTERN EXTENSION TELEGRAPH COMPANY.—This company notify that the coupons on their Six per Cent Debentures will be paid on presentation at the Consolidated Bank.

ELECTRIC LIGHTING AND HAMPSTEAD VESTRY.—This Vestry have appointed ten members, with Mr. C. H. Lowe, surveyor, to visit and report on the Crystal Palace Exhibition.

ELECTRIC LIGHT IN VICTORIA.—It is stated that the Commissioners of Railways for Victoria are about to introduce the electric light into the Flinders-street Railway Station.

EASTERN TELEGRAPH COMPANY.—This company notify that the coupons on their Five per Cent. Debentures will be payable on presentation at the banking house of Messrs. Glyn, Mills, and Co.

ELECTRIC LIGHT AT FRASERBURGH (SCOTLAND).—We learn that the electric light is being used at Fraserburgh to enable the harbour works now in course of construction to be carried on by night as well as day.

THE ELECTROLYSIS OF SULPHATE OF COPPER.—This was the title of a Paper read before the Birmingham Philosophical Society, by Dr. Gore, at a meeting held at the Mason Science College on Thursday week.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of January, 1882, amounted to £53,648, and to £47,445 in the corresponding period of 1881, being an increase of £6,203.

EASTERN EXTENSION COMPANY.—The traffic receipts of this Company for the month of January, 1882, amounted to £33,129, and to £29,434 for the corresponding period of 1881, being an increase of £3,695.

INSTITUTION OF CIVIL ENGINEERS.—At the meeting of this institution on Tuesday next, a Paper is to be read by Mr. Paget Higgs. The subject will be "The Measurement of the Candle Power of the Electric Light."

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next ordinary general meeting of this society will be held on Thursday, the 9th February, when a paper will be read by H. F. Joel, associate, on "The Pilsen Arc Light."

TELEGRAPH REVENUE OF CAPE COLONY.—According to the recent statements, the revenue derived from telegraphs in Cape Colony during November, 1881, amounted to £5,476, against £4,867 for the same month of 1880, being an increase of £609.

AN ELECTRICAL TRAMWAY FOR PARIS.—A Parisian engineer, by name M. Chappuis, has asked permission of the Municipal Council of that city to establish an overhead electrical tramway in Paris at his own expense, and as an experiment.

OVERHEAD WIRES IN NEW YORK.—An American paper says that there are 9,000 miles of telegraph and telephone lines in the streets and on the housetops of New York city, and that 3,500 of these belong to the Metropolitan Telephone Company.

MORE COMPANIES.—Two new companies are announced, viz., the Domestic Electric Lighting Company, with a capital of £50,000 in £1 shares, and the London and Globe Telephone and Maintenance Company, with a capital of £600,000 in £10 shares.

LIGHTING HELL GATE.—"It is probable," says *Engineering News* of New York, "that a Bill will be presented to Congress for an appropriation to light 'Hell Gate' by electricity. The Light House Board estimate the cost of plant at 20,000 dollars."

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 27th January, 1881, were £2,566, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

CHINESE TELEGRAPHS.—It is stated that the Chinese Government are being urged by Russia to connect their new line of telegraph with the Siberian lines. Judging from the past history of the Chinese, this junction is not likely to be effected for some time to come.

PHOSPHOR BRONZE TELEPHONE WIRES IN BELGIUM.—A Belgian contemporary states that in the wire works of M. Montefiore-Levi 900 to 1,000 kilogrammes of phosphor bronze wire for telephonic purposes are being turned out per day. (A kilogramme is 2·2lb.)

INCREASE OF TELEGRAPH TARIFFS IN AMERICA.—An American contemporary says that the Western Union Telegraph Company have greatly increased their tariffs for messages. In some cases the advance is as much as 100 per cent., and in no case is it less than 30.

THE TELEPHONE IN BERLIN.—The Berlin correspondent of the *Globe*, writing under date January 30, says:—"The postal authorities are now buying an improved telephone, which the patentee declares to be able to transmit vocal sounds from Hamburg to Berlin."

THE ELECTRIC LIGHT AT PAISLEY, NEAR GLASGOW.—On the occasion of the opening of a new town hall at Paisley on Monday last, the town was brilliantly illuminated, the abbey being lighted by electric light. Amongst those present on the occasion were Sir William and Lady Thomson.

TELEGRAPHS IN AUSTRALIA.—In September last the number of miles of telegraph wires in the various Australian colonies was as follows:—New South Wales, 13,689

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miles; Victoria, 6,675; New Zealand, 9,587; Queensland, 8,967; South Australia, 7,017; and Tasmania, 1,000 miles.

INCANDESCENT LAMPS IN CLUBS.—The Scottish Club, as we stated in our annual review, is now lit up with the British Electric Light Company's incandescent lamps, and we learn that the Junior Carlton and the Royal Thames Yacht Club are shortly to be lighted by the same means.

ELECTRIC LIGHT IN THEATRES.—An experiment with incandescent lamps as a means of illumination for the corridors and crush room of the Prince of Wales's Theatre at Liverpool was so successful that we believe it has been decided to extend the use of these lights to other parts of the house.

THE LIVERPOOL CORPORATION AND TELEGRAPH POLES.—The Liverpool Corporation's Improvement Bill to be laid before Parliament this Session contains a clause to the effect that they shall be enabled to prohibit the use of telegraph poles in all cases where it shall be deemed necessary to do so for the safety of the public.

THE SOUTH AMERICAN CABLE.—We are informed that the India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from Lima, dated 25th January, in which Mr. W. F. King says that the shore end of the Chorillos Payta section had been successfully landed at Chorillos on that day by the ss. "Dacia."

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this Company during the month of January was 3,029, estimated to produce £2,800, against 2,484 messages, producing £2,527, in the corresponding month of last year. The traffic receipts for the month of November, estimated at £2,600, realised £2,431.

THE TELEPHONE PATENT CASE.—The action brought by the United Telephone Company, who are the proprietors of Bell's and Edison's telephones, against McLean, of Edinburgh, was decided on Wednesday, judgment being given in favour of the complainants, whose patent rights the defendant was held to have infringed. An injunction has been accordingly granted.

THE LOWESTOFT CABLE REPAIRED.—The Indo-European Telegraph Company notify that, the submarine cable between Lowestoft and Germany having been repaired, their direct route between this country and the East is restored and reopened for traffic, and that messages for India, China, Australia, New Zealand, Persia, and Turkey are accepted as usual at their offices.

BRITISH AND IRISH TELEPHONE AND ELECTRIC WORKS COMPANY.—The head office of this company has been established at 20, Regent-street, Waterloo-place, S.W. The branch offices are as follow:—City: 28, Queen-street, Cheapside, E.C. Midland Office and Depôt: 5, Carr's-lane, Birmingham. South Wales Depôt: Great Western Railway Station, Newport, Mon.

THE TELEPHONE IN INDIA.—Mr. Pender, M.P., chairman of the Oriental Telephone Company, has received the following telegram from the Hon. Major Baring, member of the Council of the Governor-General of India:—"Have pleasure to declare Calcutta, Madras, Bombay Telephone Exchanges open. I congratulate you and directors on their successful inauguration."

PLATINUM.—Dr. Nichols, an American scientist, finds that the formula for the relation between the electrical resistance of platinum and its co-efficient of expansion by heat, as given by Siemens and others, are untrustworthy. From his own experiments he draws the conclusion that the temperature can be calculated with greater accuracy by its expansion than by its electrical resistance.

THE ELECTRIC LIGHT FOR THE HOUSE OF COMMONS.—The *Daily News* says:—"The electric light will not, for the present at least, be used for the illumination of the House of Commons; but should experiments in addition to those tried last year prove more satisfactory than the latter have turned out, it is probable the electric light will be laid on permanently during the Easter recess."

ELECTRIC LIGHTING AND CHELSEA VESTRY.—In consequence of a report from their surveyor, Mr. G. H. Stayton, and a recommendation from the Works Committee, regarding the Electric Lighting Bills to be brought forward this Session, the Chelsea Vestry have passed a resolution that the Bills require amending, and that steps should be taken to procure their amendment, and to watch their progress.

NEWS FROM MILAN.—*La Perseveranza* of Milan states that Mr. James Shepherd, who was deputed by the municipality to visit Paris and London to inquire into the various systems of electric lighting and transmission of power by electricity in use in those cities, has returned to Milan. Our contemporary adds that Mr. Shepherd has been appointed the representative for Italy of the Edison Company.

ERRATA.—Page 174, 1st col., 1st and 2nd line, for "forming with sulphuric acid a radical compound," read "with sulphuric acid radical a compound." Also, on page 161, 1st col., the fourth Note should read thus:—The Postmaster-General has, in reference to a request from the Wolverhampton Chamber of Commerce, stated it is not in his power to allow the word "Wolverhampton" to be paid for as one word on foreign telegrams.

NEW CABLE FOR THE FORTH.—The ss. "Morna," which has been chartered to lay a new telegraph cable between Aberdour and Granton, arrived off the latter place on Monday morning with the new cable on board. When this has been accomplished, she will proceed to overhaul the old cable lying between Burntisland and Granton. The new cable, it is stated, will be worked by the Post Office, and the old one by the North British Railway Company.

THE RIGHI TELEPHONE.—Experiments have recently been carried out at Bologna with an improved Righi telephone. Two transmitters were placed on the stage of the theatre, and connected by wires to receivers in a room some mile and a half or more distant. The receivers were of two kinds, small and large. The small could be placed to the ear. The large were fixed to a wall, and enabled everyone in the room, within a radius of several yards, to hear what was being said in the theatre.

ELECTRIC LIGHT AND GAS IN BARNSLEY.—The experiment with the electric light as an illuminant for certain streets in Barnsley has terminated, and the Town Council have gone back to gas, but not at the old prices. A reduction of 5s. per lamp on all public lamps, and of 6d. per 1,000 cubic feet for private houses, has been made. The corporation appear to have been very pleased with the result of their experiment, and at a recent meeting some members were rather inclined to stand out for a still greater reduction than that stated above.

THE ELECTRIC LIGHT FOR LIGHTHOUSES.—The London correspondent of a provincial contemporary says:—The Board of Trinity House is engaged in considering the extension of the electric light for use in the lighthouses upon the British coasts, and its general adoption is likely shortly to be decided upon. There are forty-six French lighthouses into which the electric light will shortly be introduced, at a

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yearly expenditure of £340,000. We have at present five lighthouses in which the electric light is in operation, and France has four.

ELECTRIC LIGHT FOR HULL.—In our issue of the 14th January we gave some particulars of the tenders sent in by the Brush Company and Messrs. Siemens for lighting this town. We then stated that the committee appointed to consider the tenders had recommended the council to accept Messrs. Siemens' alternative tender of £1,550 for hire and working of the plant for twelve months. This recommendation was adopted by the council at a meeting held a few days since, and we presume it will not be long before operations are commenced.

THE ELECTRIC LIGHT IN DERBY.—Messrs. John Davis and Son, colliery instrument makers and electrical engineers, of Derby, have installed several Maxim incandescent lamps in their works to demonstrate its adaptability for mines, works, mills, and domestic purposes. They have also arranged to supply these lamps to a tailoring establishment in the same town, and intend shortly to lay down an extensive plant to supply neighbouring shops and offices with incandescent and arc lights. This is the first appearance of the electric light in Derby.

EARTH CURRENTS.—Mr. W. H. Preece writes to *Nature* of the 26th January:—"A remarkable and unusual sudden appearance of earth currents occurred between 10:15 and and 10:20 p.m. Greenwich time on the evening of January 19, on lines running east and west. They disappeared as suddenly as they arrived. They were weak, measuring, when at a maximum, 3·3 milliampères. Traces remained until 10:50. It will be interesting to learn if simultaneous disturbances occurred in our magnetic observatories. I have not heard of any aurora being visible that night."

ELECTRIC LIGHT COMPANIES IN FRANCE.—The Paris correspondent of the *Liverpool Journal of Commerce* writes, under date January 30:—"A dispute is still pending between Mr. Edison and Mr. Maxim with respect to their incandescent lamps. How it will end, whether by a costly judicial suit or by a judicious compromise, it is impossible to foretell, but, meanwhile, every effort is being made to cover new ground. Amongst the most recently-formed companies in Paris may be mentioned those for the working of the two last-named lamps, and another for the Gramme machine, although the patent in the latter case will soon expire."

ELECTRIC LIGHT AND GAS IN BELGIUM.—*L'Industrie Belge* for the 26th January gives the following comparative figures of the cost of the Jaspar system of electric lighting and gas. According to our contemporary, M. Jaspar's factory in the Rue Jonfosse at Liege was originally lighted by forty gas burners, at a cost of 1·25 francs per hour. The expense of lighting the same with his lamps is—For carbons 20 centimes, coal and oil for motor and machine 15 centimes, calculated for wear and tear 15 centimes, total 50 centimes, or half a franc. M. Jaspar uses reflectors to a very large extent, thereby avoiding shadows and lighting up all corners.

TELEGRAPH STORES WANTED.—Tenders are required for the supply of telegraph poles, iron, steel, and copper wire, insulated wire, iron binding wire, screws, insulators, earth plates, glass battery cells, pig lead, brass, telegraphic ink and colours, sulphate of copper, &c. Particulars can be obtained on payment of 1 mark 20 (1s. 3d.) from Den Kgl. Generaldirektion der Eisenbahnen in Elsass, Lothringen, Strassburg, where tenders will be received up to the 15th instant. Tenders are also required for the supply of sundry telegraph material for the Dutch colonies. Particulars can be obtained of the Inspector of Telegraphs, Binnenhof 2, The Hague, who will receive tenders up to the 13th inst.

THE SCINTILLATION OF STARS AND COLLIERY EXPLOSIONS.—M. Somzee, the well-known Belgian mining engineer, has expressed the belief that the increased scintillation of the stars which precedes a fall of the barometer may be made use of as a warning for collieries. A fall in the barometer is generally followed by an increase in the amount of gas given off in a colliery. M. Somzee would establish observatories which should be in telegraphic communication with the mining centres, and any increase in the scintillation of the stars should be telegraphed at once to these centres; or the fact might be automatically announced in each mine by a somewhat similar instrument to the photophone.

CAN A CITY EXPERIMENT?—Judge Gibson, of the United States Legislature, says No. In the case of the city of Fond du Lac (Wisconsin), which had entered into a contract for the introduction of the electric light by the United States Electric Light Company, on the tower system, and against which the gas company had appealed, asking for a preliminary injunction prohibiting the electric light company from erecting towers, &c., the above judge granted the injunction, and gave it as his opinion that the city has no right to enter into experiments, and no power under its charter to manufacture its own light. Fond du Lac will, therefore, be compelled to do without the electric light, at all events for the present.

A NEW TIME SIGNALLING SYSTEM FOR AMERICA.—An influential company has just been formed in America, to be called the Standard Time Company. Having carefully examined into the various systems of synchronising clocks in use both in America and Europe, the one in use in London, and known as Barraud and Lunds', has been adopted by them. The arrangements include the whole of the American Continent as well as the United States, and an effort will be made to bring about a concerted system of time signalling over the whole of the States; local affiliated companies are to be formed, and we shall probably soon hear that our transatlantic cousins are making as extensive a use of time signals as they do of the telephone.

A NOVEL APPLICATION OF ELECTRICITY.—A method of preventing conscripts from bending their knees in order to detract from their height has been invented by M. Cazala, and is now employed in the Spanish army. The method consists in having two electric contacts against which the hinder part of the knees should press if the conscript is standing upright, these contacts being in connection with a battery and bell; the latter is kept ringing as long as the knees press the contacts, but the moment any stooping takes place the bell stops, and the conscript is, of course, detected. The same device may be connected to the sliding bar, which is pressed on the head, and thus ensure correct measurement. The above was described in a recent number of *La Lumière Electrique*.

TIME SIGNALS BY TELEPHONE.—We are informed that Messrs. Barraud and Lunds, the patentees of the system of time signalling and clock synchronising so largely adopted in London, have applied to the Postal Telegraph Department for an extension of their time exchange to telephone purposes. For some time they have been conducting experiments with the object of utilising their existing system for telephoning, which have resulted in a perfect success. They now propose to duplicate and extend their system, so that every telephone subscriber may be able to receive an hourly

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Greenwich time current by simply hanging his receiver on a hook in his telephone, marked "time signal," without any interference with the speaking power of the instruments. The matter is at present under the consideration of the Post Office authorities.

British Honduras and Cuba Submarine Telegraph Company.—The formation of this Company is announced with a capital of £120,000 in £10 shares. The directors are Sir J. Carmichael, C. W. Stronge, Esq., Alan Lambert, Esq., and B. M. de Zulueta, Esq. The consulting engineers are Sir S. Canning and R. Sabine, Esq. The objects of the Company are to purchase and lay down between Belize, the capital of British Honduras, and Cape Antonio, in Cuba, a cable 380 miles long, manufactured by Messrs. W. T. Henley, and now lying in their tanks. The Government of British Honduras have guaranteed a sum of £1,000 per annum for twenty years, for telegrams from or to that colony transmitted by this cable. It is calculated that the cable will be laid and working by the end of April. The prospectus can be had, and all documents seen, at the offices of Messrs. Freeman and Bothamley, of 13, Queen-street, Cheapside, E.C.

Anglo-American Telegraph Company.—The board of directors of this company have resolved (after placing £37,500 to the credit of the renewal fund) to recommend to the proprietors at the half-yearly meeting of the company, to be held on the 10th inst., the declaration of the following dividends, all free of income-tax:—1. A balance dividend of 15s. per cent. upon the ordinary consolidated stock for the year ended 31st December, 1881; 2. A balance dividend of 10s. per cent. on the preferred stock for the year ended 31st December, 1881; and (3), a dividend of 20s. per cent. on the deferred stock for the year ended 31st December, 1881, all payable on 11th February. There will then remain a balance of about £4,800 to be carried forward to the next account. The above dividends, together with those already paid, will amount to 3½ per cent. on the ordinary consolidated stock, 6 per cent. on the preferred stock, and 1 per cent. on the deferred stock for the year 1881.

The History of Electricity.—An interesting Paper on "The History and Development of Electrical Science" was read at a meeting of the South Staffordshire Mill and Forge Managers' Association, held in the Mining Museum, Dudley, on Saturday last, by Mr. James Solly, ironmaster. The author referred to the early experiments made with amber, and subsequently reviewed the discoveries of Gilbert, Franklin, Leyden, and Davy. He alluded to the introduction of the electric telegraph in 1837, and compared it with the improved instruments now in use, by means of which he said 30,000,000 telegrams were annually despatched in Great Britain. Turning to the production of electricity for lighting and other purposes, Mr. Solly passed on to the various systems of electric lighting now before the public, and mentioned that an incandescent light had been brought out by Mr. Lancaster, of Birmingham. At the finish of the Paper Mr. Kerr, of the National Telephone Company, said a few words on telephony, and explained the principle of the telephone. A discussion followed.

Electrical Transmission of Power.—On Sunday last Mr. Carpenter delivered a lecture in Glasgow, under the auspices of the Glasgow Sunday Society, on "The Transmission of Power and the Storage of Force." Mr. Carpenter, after alluding to the batteries of Grove, Planté, and Faure, exhibited the latest form of secondary battery, the invention of Mr. Sutton, of the Mining School at Ballarat, in regard to which he spoke very highly, and which, we believe, was on this occasion shown in public for the second time only. The connection between magnetism and electricity was explained, as were the various forms of dynamo machines and electric lamps. By means of a diagram he showed that a plough might be worked by a dynamo-electric machine driven by an electric current from a dynamo at a distance, worked either by steam or water power. The lecture was abundantly illustrated by experiments, and by diagrams shown with oxy-hydrogen light. Mr. Carpenter is to deliver lectures on this subject in Dundee, Perth, Brechin, Montrose, and Kirkcaldy, under the Gilchrist Trust.

The Opposition to Electric Lighting Bills.—The *Journal of Gas Lighting* in a recent number gives the following sober advice to its clients:—"We have already expressed the opinion that neither justice nor expediency favours a policy of factious opposition on the part of Gas Companies to electric lighting undertakings. At the same time it is a duty that the former owe to themselves and the public to demand a searching investigation into the reasons upon which Parliament will now be asked to revise the decision arrived at in respect of the same matter by the former committee. If the promoters of electric lighting Bills are in possession of a strong case, they will not object to disclose it; but it is not to be expected that they alone are to be endowed with a valuable charter, to make free use of public thoroughfares everywhere for their own ends, without at the same time incurring obligations, or at least showing cause why they should be so especially favoured." This is reason and moderation which we hardly expected from a contemporary who has said such very unkind things about electric lighting and its supporters.

A Telegraph Company's Liability in America.—A decision on the liability of a telegraph company for errors in telegrams transmitted over its lines was recently given by Judge Wilson, in the case of Thomas J. Martin, jun., *v.* the Western Union Telegraph Company, which is reported as follows in New York papers:—The plaintiff was a speculator on 'Change, and sent a message in cipher to a customer, and the message was transmitted correctly, with the exception that the word "sixteen" was sent as "sixty." The message explained the condition of the market, and, owing to the information contained, various sales were made on the strength of the telegram as read by the parties receiving it, involving a loss, as claimed, of 422 dollars, which amount was recovered in the lower court. The message was intelligible only to the person sending the message and the one receiving it, and the telegraph company and its agents had no means of solving the message so as to be certain of transmitting it absolutely correct. Judge Wilson held that to make a person responsible for ulterior consequences, involving the payment of damages which do not follow directly, he should be informed with reasonable preciseness of the purpose for which the subject of the contract was intended by the other. The company, therefore, in order to be held responsible for remote consequences, should have been made acquainted with the purport and meaning of the communication presented for transmission. This was the well-settled rule in both England and America. As the message in the present case was meaningless to the company, it would be absurd to claim the latter either had in contemplation or could be reasonably supposed to have had in contemplation, at the time of transmitting it, damages for a loss such as had occurred. The amount recovered should have been limited to the amount paid for the message, with interest. The judgment of the court below would be reversed, and the cause remanded.

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THE TRANSPORT AND DISTRIBUTION OF ENERGY BY ELECTRICITY.*

(*Concluded from page* 142.)

Magneto and Dynamo-Electric Machines.

When a wire is moved across a magnetic field it is traversed by a current, the direction of which is determined by the nature of the field and the direction the wire moves in.

The electromotive force in each element of the wire is proportional, 1st, to the length of that element, 2nd, to the speed of the wire perpendicularly to the lines of force, and 3rd, to the intensity of the magnetic field. Reciprocally if a wire is placed in a magnetic field, and a current sent through it, the wire will tend to move in a contrary direction to that which it would require to move in to generate the current. Magneto and dynamo electric generators are based on these laws. In the former the field is produced by permanent magnets, in the latter by electro-magnets, either excited by the current itself, or the current from an external source, such as a battery or another generator. These generally consist of a magnetic field in which revolves a bobbin of wire forming a continuous conductor, in which the current is developed.

When these machines are used as generators the electromotive force for a given machine is proportional, 1st, to the intensity of its magnetic field; 2nd, to the linear velocity of the wire across the magnetic field, that is, to the angular velocity of the bobbin and the mean distance of the wire from the centre, or axis of rotation; 3rd, to the length of wire forming the spires of the bobbin.

When these machines are used as a motor, by sending a current through the coil the mechanical couple tending to turn the bobbin is proportional for a given machine to the magnetic field and the intensity of the current, but is independent of the velocity of the bobbin. Another important fact is that for a certain intensity of current there always corresponds in a machine employed as motor a determinate mechanical effort, and one only.

Let us suppose that two identical machines are connected up for the transmission of power, one acting as generator, the other as receiver. The first is connected to a prime mover, the second to some mechanical apparatus, such as a brake imposing a constant work on it per turn. The first machine increases in speed until the second machine begins to turn. From that instant the intensity is constant, and if the speed of the first machine increases, the speed of the second will increase also. The two machines being identical, and traversed by the same current, which besides is constant, the mechanical efforts which they exert and the work done per turn are equal, the speeds only being different. The work produced by the first machine is measured by the product of its speed and the work per turn; the work done by the second is equally the product of its speed and the work per turn. The economic yield is, therefore, measured by the ratio of these two speeds; but whatever these speeds may be, the current is constant. The resistance being invariable the difference of the electromotive forces which engender it ought to be equally invariable; but the magnetic field being the same in the two machines, the respective electromotive forces are measured by the speeds of rotation. The difference of these speeds will, therefore, be constant. We see that the yield is measured by the ratio of the two speeds, of which the difference is constant. Hence there will be an advantage in taking the speeds as great as possible, in order to make the ratio as near unity as possible, and increase the efficiency.

Application of the Laws.

The principle that the economic yield is independent of the distance is one which has been misunderstood in practice, and there have been scientists who declared that to transmit the the power of Niagara by wire would need all the copper in the mines of Lake Superior. And, since the principle has been understood, there have, on the other hand, been writers who have asserted that a small copper cable ½in. in diameter would distribute the power of the Falls to the whole world. When it is remembered that this power is at least two million horse-power, it is obvious that there is some gross error here. In fact, if we neglect the resistance of the conductor, and take the internal resistance of the machine as a mere fraction of an ohm, in order to transport electric power 75 kilometres with an economic yield of 50 per cent., it will be necessary for the electromotive force to be over a million volts, a tension comparable with the lightning flash. It is theoretically certain that a wire of a diameter quite small can transmit a limitless quantity of energy, provided the tension is as elevated as the section is diminutive; but to this tension there is a limit imposed by difficulties of insulation, and the authors of the project for transporting the energy of Niagara by a conductor of ½in. in diameter appear to consider these difficulties as resolved. Why did they stop at ½in. diameter, we may ask, and not employ the ordinary telegraph wire? It would only have required a higher tension, and when one reckons by millions of volts it is useless to hesitate a little.

M. Deprez then considers the case of two identical dynamo-electric machines of the Gramme type, C, such as were employed at Chatham, and he finds that, with this arrangement, it is possible to transmit a useful work of 10 horse-power to a distance of 50 kilometres by means of an ordinary telegraph wire, the initial motive force being about 16 horse-power. He arrives at this result by simple calculations based on the laws laid down; but, in practice, the useful work will be a little less, owing to self-induction currents in the machines, friction, &c. The corresponding electromotive force would be 6,952 volts, equal to that of 6,440 Daniell cells. This tension is not an impracticable one, for the induction sparks of over 7,000 volts have been conveyed to a distance of several miles by means of insulated wires for the purpose of firing mines.

Graphic Theory of Dynamo-Electric Machines.

The distribution of energy by electricity supposes that we have a number of diverse apparatus in circuit with the same generator, and actuated by it. The generator must be arranged to keep any or all of these going at once, the production of current varying with the requirements of the apparatus. Under these conditions the total quantity of energy produced, namely, E I, must be variable, and the best way of arriving at this is to make E or I vary while keeping the other factor constant. If we make E vary and keep I constant we shall join all the receiving apparatus "in series," and vary E by means of a potential regulator. If we resolve to make I vary, and keep E constant, we shall join all the receivers in "multiple arc," that is, separate circuits, each connected to the poles of the machine. But even here it will be necessary to vary E to some extent, for the internal resistance of the generator has to be considered. For, suppose we have at first only one receiving circuit between the poles of resistance R, the intensity of current I will be $= \frac{E}{r + R}$, where r is the internal resistance of the generator. If now we add another circuit with its receiver of the same resistance R, we shall have the intensity $I' = \frac{E}{r + \frac{R}{2}}$ an expression which is not exactly double the first. Hence a potential regulator, to keep the difference of potential between the poles of the generator always e, is necessary in both cases. This regulator must work promptly and automically; it must cause the generator just to yield the current necessary to work the machines; and each apparatus must receive its due share of the current independently of the rest. For this purpose the multiple arc, or quantity system of distribution, is preferable to the "series" or tension system.

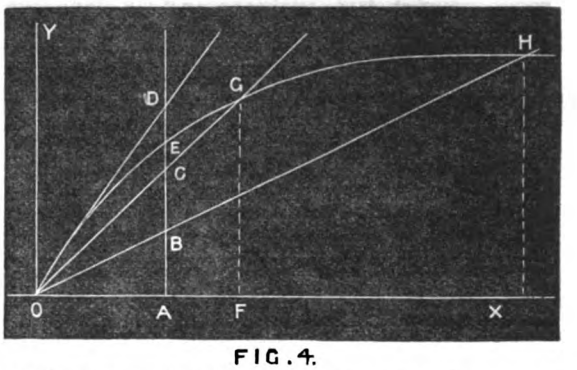

FIG. 4.

The following graphical theorems are applicable to both ways of connecting up. They give what M. Deprez calls the "machine characteristic" for different conditions of working, and apply to any continuous current generator.

The characteristic for a given speed is got by making the two circuits of the armature and magnets quite distinct, and sending a current of known strength round the coils of the latter. The armature is then started, and the electromotive force corresponding to the velocity V_1 is measured. Next the current is varied, keeping V_1 constant, and for each value of I a definite E.M.F., E. Two co-ordinates X and Y are then drawn, and I is measured along X, while E is measured along Y. In this way a series of points gives us a curve characterising the machine when driven at the speed V_1. Such a curve is represented in Figure 4 by the line O G H. If, now, we connect the two circuits of armature and magnets, and drive the armature at the speed V_1, the current I will excite the magnets. Take O F equal to I, then F G will be the correspond-

* Abstract of a paper by M. Marcel Deprez in *La Lumière Electrique*.

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ing E.M.F., and since $R = \frac{E}{I}$, the tangent of the angle F O G, we have the resistance of the circuit represented by the tangent of an angle. Diminishing the resistance will have the effect of flattening the angle F O G, and from the sweep of the curve we see that the E.M.F. would rapidly increase at first, then become constant, an effect due to the saturation of the magnets. On the other hand, increasing the resistance increases the angle F O G, and diminishes the E.M.F. until at the origin O. Where the resistance is represented by the tangent of the angle D O A. it becomes *nil*, an effect due to the demagnetisation of the magnets.

The characteristic for a velocity V_1 once drawn, gives us that for a velocity V_2, by multiplying the ordinates of the first curve by the ratio $\frac{V_2}{V_1}$. Again, if the velocity is kept the same, but the number of turns of wire on the armature changed from t_1 to t_2, the new curve can be got by simply multiplying the ordinates of the first by the ratio $\frac{t_2}{t_1}$, provided always that the volume of the wire has not been much altered.

If we examine a characteristic we shall see that it is very nearly a straight line until the point of saturation of the magnets is approached. By employing magnets of relatively greater mass than the armature this point can be deferred and the straight portion of the curve lengthened. When electricity is supplied on a large scale this result will doubtless be taken advantage of, but at present the Gramme machine gives a straight enough line for all practical purposes. Let O^1 G, Figure 5, be the rectilinear characteristic of a machine. If a constant magnetic field produced by a current O^1 O be added to the machine, the new characteristic will be represented by F G, the portion of O^1 G beyond the new axis of Y. If D O X be the angle whose tangent is the internal resistance of the machine, F G and O D will generally intersect, and as the portion of the ordinate intercepted by these two lines represents the difference of potential e at the poles of the generator it follows that this difference is a very variable quantity. But e must be kept constant in distributing current to receivers joined up in "quantity," and the Figure 5 shows how this can be done; for by increasing the velocity of the armature, the line O^1 G will be shifted towards the axis of Y, and for a certain speed will take the position O^1 C parallel to O D. The difference of potential e will then be always equal to C D, whatever the resistance C O X of the circuit may be.

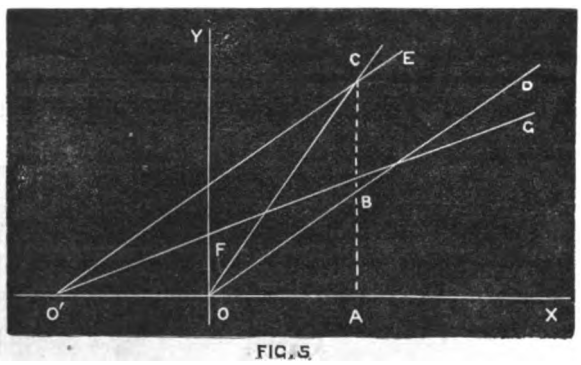


FIG. 5.

It is obvious, therefore, that we must begin by raising the speed of the machine to a certain value, V. Then, if E_0 is the E.M.F. of the constant external current exciting the field magnets, and E the total E.M.F., $\frac{E - E_0}{I}$ will be the tangent of the angle made by the rectilinear characteristic with X. This expression should be equal to the tangent of the angle denoting the internal resistance r. If it is not a velocity, V′ must be found giving

$$\frac{V'}{V} \cdot \frac{E - E_0}{I} = r,$$

whence we have

$$V' = \frac{r V I}{E - E_0}.$$

The external exciting current, then, must be determined by the constant difference of potential we desire to establish. This done, a wire is to be connected to each pole, and at all the points we wish to use a portion of the energy produced we must join these two thick conductors by derived circuits of suitable resistance. The earth itself can be used in place of one of these wires. When there are numerous derivations the E.M.F. throughout the conductors will not remain constant. There will be a fall, just as there is a fall of pressure in gas pipes, but it will not cause any practical difficulty

We come to the distribution of electricity when the receivers are arranged in series, a condition requiring that I is constant. Let Ia be the total current developed in the armature, Ib the derived portion exciting the magnets, Ix the part flowing in the external circuit, a the resistance of the ring, b the resistance of the magnets, x the resistance of the external circuit, E the total E.M.F., and e the E.M.F. at the points where the derived inductive circuit is separated from the useful external circuit, that is the difference of potential between the poles of the generator. The intensity Ix has to be kept constant. We have at first

$$Ia = Ib + Ix;$$

that is, the total current is the sum of its derivations.

In considering the difference of potential at the point of derivation we have

$$Ix = \frac{e}{x} \text{ and } Ib = \frac{e}{b}.$$

Hence we have

$$Ia = \frac{e}{x} + \frac{e}{b}.$$

But Ia has another expression; it is equal to the total E.M.F. divided by the total resistance. The latter is equal to

$$a + \frac{1}{\frac{1}{b} + \frac{1}{x}};$$

hence we have

$$Ia = \frac{E}{a + \frac{1}{\frac{1}{b} + \frac{1}{x}}}.$$

In equating the two expressions for Ia we have

$$\frac{e}{b} + \frac{e}{x} = \frac{E}{a + \frac{1}{\frac{1}{b} + \frac{1}{x}}},$$

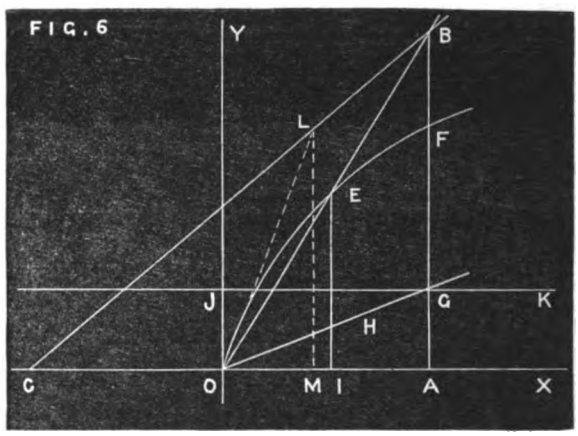
whence we have

$$\frac{(a+b)x + ab}{x} = \frac{E}{\frac{e}{b}}.$$

But $\frac{e}{b}$ is Ib, and hence we have

$$\frac{E}{Ib} = \frac{(a+b)x + ab}{x}.$$

This done, let O E F, Fig. 6, be the characteristic of the



machine; draw C B from its equation $y = (a+b)x \times ab$; mark off O A = x; draw A B and the lines O B and E I; take O J = b, and draw J K parallel to the axis of X, meeting the ordinate A B at G; draw O G meeting E I in H. The length I H thus determined will represent the intensity Ix sought. From similar triangles, O I E and O A B, we have

$$\frac{EI}{OI} = \frac{AB}{OA} = \frac{y}{x} = \frac{(a+b)x + ab}{x} = \frac{E}{Ib}.$$

Also from the diagram we see that E I is equal to E and O I to Ib. Further, the similar triangles O I H and O A B give

$$\frac{IH}{OI} = \frac{AG}{OA},$$

whence

$$\frac{IH}{Ib} = \frac{b}{x},$$

and

$$IH = Ib\frac{b}{x} = \frac{e}{b} + \frac{b}{x} = \frac{e}{x} = Ix.$$

The above diagram is, therefore, a plan for representing the

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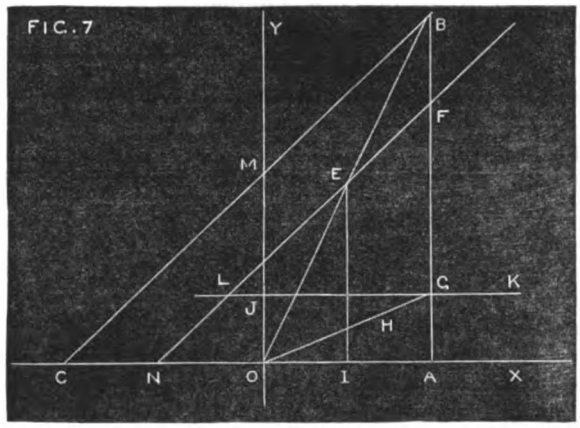
quantity Ix, which is kept constant. From it we can also find the resistance at which the magnets will be demagnetised; for if we draw O L tangent to the characteristic at the origin, and from the point of intersection L draw the perpendicular L M, we shall have O M as the resistance sought.



To see how Ix can be kept constant, we have to apply the system of rectilinear characteristics. Thus in Fig. 7 let $C B = y = (a + b)x + a b$. Now, let the armature be driven at the particular speed which makes the characteristic parallel to C B, and let N F be the resulting characteristic; make $O J = b$; draw J K parallel to the axis of X; make O A equal x; draw A B meeting C B in B, and join B to the origin. This line B O intersects the characteristic at E, from which drop E I and join O G. From the previous demonstration we know that H I = Ix, and we have now to show that H I is constant.

From similar triangles we have

$$\frac{IH}{AG} = \frac{GI}{AF} = \frac{OE}{OB} = \frac{OL}{OM};$$

but this last ratio is constant, therefore

$$\frac{Ix}{b} = a, \text{ and } Ix = a b, \text{ a constant value.}$$

The process employed to determine the speed the machine ought to have for the characteristic to have the inclination desired, is similar to that already described. In the actual case it is applied as follows:—The straight line which determines the inclination to obtain, having for equation $y = (a + b)x + a b$ its co-efficient of inclination is $-(a + b)$; that of the old characteristic obtained with the speed V and the current I being $\frac{E - E_0}{I}$. It is necessary to seek a speed V^1, such that we have

$$\frac{V^1}{V}\,\frac{E - E_0}{I} = -(a + b);$$

therefore

$$V^1 = \frac{-(a + b)}{\frac{E - E_0}{I}}.$$

But $-(a + b)$ is the total resistance,

where the magnets and armature are connected in a single circuit as ordinarily, or R in preceding theorems. We conclude, therefore, that in both cases, whether it is a question of keeping the difference of potential or the intensity of current constant, the velocity of the armature required to bring the characteristic to the required parallelism is the same; the difference lies in the method of joining the induced and inducing circuits. The same apparatus, therefore, can furnish both results by the action of a commutator.

TELEPHONE WIRES IN EDINBURGH.

Mr. Morham, city superintendent, has, at the request of the committee of the town council appointed to inquire into this subject, prepared a report in which he states that he has made inquiries in other cities, and finds that in most of these places, as in Edinburgh, the matter is still under consideration. It is generally felt that the rapidly growing use of the telephone renders the exercise of some control by the authorities very desirable; and though the liberty hitherto allowed in the matter of putting up wires constitutes a special element of difficulty, it becomes the more urgent that such control should ere long be put in practice. It is generally held that telephone wires must be overhead on account of their liability to induction when placed underground. This, however, though a real, is not an insuperable difficulty, and in Paris, with few exceptions, the wires for telegraph, telephone, and electric light, as well as the piping for pneumatic clocks, are all underground, the extensive system of drains of large calibre affording special facilities for this. In Berlin, the systems of electric communication, both the telegraph wires, which are below, and those of the telephone, which are above ground, are entirely in the hands of the Government; and though private communication by telephone is not precluded, it must be through Government wires and central stations. In other towns in Germany this control appears to be less rigid, and private wires are allowed, only they must be sanctioned by both Government and Corporation. In Vienna these matters are chiefly, but not exclusively, in the hands of Government, but always under strict supervision by the authorities. Telephones have not yet been extensively introduced, though they are beginning to be used; and the wires are generally, like those for the telegraphs, carried on brackets along the fronts of the houses rather than above the roofs. In Brussels the regulation of wires is under consideration. Hitherto they appear to have been allowed pretty much as in this country, without special authority. They are not yet so numerous as here; but in addition to those for telegraph and and telephone purposes, there are a number for public clocks. The only place in this country, so far as the reporter has heard, in which definite steps have been taken with reference to such matters is Dundee, where, as the committee are aware, private parties are required to make application in set form to the corporation for leave to erect wires. The points chiefly to be aimed at are:—1, To maintain the public right in the streets, &c.; 2, to guard against accidents from wire breaking, &c.; 3, to prevent disfigurement by wires, poles, &c. The public right in the streets is, to a certain extent, invaded by every unauthorised wire or other erection which subtends a public street or place; but there can be little difficulty in dealing with this question, so long as the parties are not suffered to acquire a prescriptive right. The question of public safety requires careful attention. The reporter has made numerous inquiries on the subject, but finds that accidents from the fall of wires are of very rare occurrence, and there is some diversity of opinion as to what would ordinarily happen were a wire to break; but though in many cases no serious effects would probably ensue, it must be obvious that in others it might be otherwise, and the subject is one requiring special investigation. With regard to amenity, it is not easy to determine how far "business requirements" should be allowed to prevail over other considerations; but few who take an interest in having the city to look its best, can see with pleasure the multitude of wires which span the streets in so many directions, or the conspicuous telegraph poles connected with them. It remains to consider as to the measures to be adopted to improve the existing state of matters and provide for future regulation. The Parisian system meets most completely all the points above indicated. The wires are conveyed in the sewers underground, for which the parties must obtain permission of the authorities; while by this arrangement all danger of accident through wires breaking, or interference with the amenity of the streets, is entirely avoided. But the expense of applying the system to places not prepared for it must be a serious obstacle to its adoption; and, short of this, some such arrangement as the following is suggested:—That lines should be laid over houses rather than over thoroughfares; and that where really necessary to cross a thnroughfare, the crossing should be as nearly as possible at right angles to the street. By this means not only would opportunity of points of support be more frequent, and long stretches of wire avoided, but even should a wire break it would, except at crossings, have only a few feet to fall, and would fall where no one would have any chance of being injured, and the wires with their fixings would not only be less conspicuous, but even where visible, their subjection to something like a system could scarcely fail to be more sightly than where the chief guiding principle is the shortest cut. In carrying out any such arrangement, it would be necessary not only to insist on applications for leave to continue existing, or to form new lines, but there would require to be a competent inspector to see that no lines were put up without being so authorised, and from time to time to examine all lines and see that they are made safe, without, however, relieving the parties of responsibility in the event of accidents occurring. It is also to be considered whether a substantial or a merely nominal charge should be made for leave to carry wires across public thoroughfares; whether something more than a nominal charge might have the effect of inducing parties as far as possible to avoid crossing thoroughfares, and make the best bargain they could for the house tops; and whether, with the same view, it might not be well that the rate of charge should bear some proportion to the length of the stretch—higher rates being charged for longer stretches, with a view to discourage the latter, and avoid sources of danger and unsightliness.

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NOTICE.—OUR SUPPLEMENT.

The supplement containing "Hints to Electric Light Engineers," published with our issue of the 7th January, can now be had at the office in pamphlet form, price one penny.

THE TELEPHONE AND THE STATE.

We are threatened with a series of recurrent rumours by no means conducive to telephonic enterprise, or to the maintenance of good relations between the Post Office and the telephone companies. One day last week a report was spread upon the Stock Exchange that the Government had it in contemplation to buy up the interests of the existing companies, and to carry on their business on its own account. That such a transparent cover for Stock Exchange dealings should have been thought worthy of serious leader writing in several of the metropolitan newspapers is exceedingly disquieting; for what has been received once with credit will be credited again, and so long as it is found to pay will be served up whenever the "market" is in need of artificial animation. With this state of things in view it seems to us that the Postal authorities should lose no time in making an official announcement once and for all as to its intentions; and we may be thankful that the Parliamentary Session is near at hand, when an opportunity for so doing will, no doubt, be easily found.

Meantime, we may point to a few circumstances which seem to render the report incredible, even if we had no good authority for saying that it was unfounded. The introduction of the telephone system for public service in this country was, as will be remembered, a most anomalous proceeding. Some people even went the length of saying that its intrusive and, as the event showed, illegal, competition with the State monopoly was a move to get itself bought over by the monopolists. That some such hopes might have been entertained at the time we think quite reasonable, and by no means blameworthy. But if, after securing an emphatic legal decision in its favour, and before the telephone companies had enlarged their sphere of operations to any considerable extent, the Government was not inclined to strike a bargain for the absorption of the defeated companies, it is hardly likely that it will be more inclined to do so now. This, however, is purely conjectural; and so also is the, to all appearance, natural inference that, if the moment of defeat was not favourable to a modest estimate of their pretensions, that moment has not arrived for the companies even yet. If negotiations with a view to Government control were not opened twelve months ago, there seems little reason for their revival; and if, on the other hand, they were opened and fell through at the time, there is still less hope of their being completed now.

One other practical consideration would also point to the non-interference of the Postal Telegraph Department with, at least, what constitutes the bulk of the telephone companies' business. That business is, up to the present, purely of a local character, being little more than an improved system of speaking tubes capable of offering great facilities for personal communication between various points in one locality, but not capable, as yet, of competing with the telegraph despatch lines. If it ever does threaten to so compete with them we can easily predict what will happen. But at present the facilities offered are what may, without disparagement, be called petty; they are elaborated with special regard to detail of a personal kind, and require for their successful administration a considerable amount of "push," which is only to be had where the promoters are seeking dividends. The Post Office is not exactly adapted for that sort of thing. If the public like it, and are satisfied, as well they may be, so far so good; but it is by no means certain that they would be satisfied with a postal system of management; and, besides, the Post Office would be more cautious, more fastidious, more scrupulous, and more rigorous than private enterprise can afford to be, and more so, perhaps, than the public would now willingly submit to.

This much, at all events, may be said of the telephonic system as it is at present. What it may develop into is a different matter; and just now there are signs that this wonderfully versatile appliance may be converted to uses for which at first it seemed ill-adapted. We are not referring to the project of tapping the stage and the pulpit telephonically, or of laying on operatic music, like gas, for the use of every householder. There may be people in this world who go to operas and theatres and churches only to listen; and for such as these the fact that you can actually hear an orchestra or a voice, or a voice and a tune, at one and the same time if only you have faith, and nobody bothers you, may be exceedingly interesting, perhaps even profitable; but that a Government department would enter upon this kind of business is, to say the least of it, problematical. The application of the telephone to long lines is in quite another category, and

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the possibility of connecting such lines to the local system of telephone exchanges is, it would seem, being seriously considered in several quarters. An exceptionally long line between Manchester and Liverpool is reported to be a great success; and there are rumours of trying the experiment on lines of far greater lengths, not for the framing of sensational newspaper paragraphs, but for practical every-day working. New forms of instruments will, no doubt, be called into requisition for such purposes as these, and we have no doubt that new forms will be forthcoming. There are even now many more patterns than are ever used, the companies themselves having had a lively sense of the pains as well as profits of unrestricted competition forced upon them in the shape of patents which must be either bought or fought. From Germany, too, we hear that under instructions of the Government some important experiments are being carried on "with the view of improving the telephone as a medium of transmitting sounds."

We may confidently surmise that all this portends some extension of the telephone to a quite new field of usefulness, and that the trunk lines of the respective Governments will be requisitioned for this purpose. The interests of the telephone companies will be greatly furthered by such development; and none the less so even though the Governments retain the direct control of it in their own hands, as indeed they probably will. On the whole we cannot see anything in the outlook either to alarm the proprietors of telephone property, or to encourage them in the belief that they will be soon relieved of it.

THE CRYSTAL PALACE EXHIBITION.

Slowly, but surely, the Electrical Exhibition at the Crystal Palace is becoming a reality. Stalls are being rapidly filled, and the exhibitors of the various lights are hastening their work. On Tuesday last, when the prizes of the late Woollen Exhibition were given to the respective winners by the Lord Mayor, several lights, till then new to the Palace, were in operation. How few electricians realised till within the last five years the capabilities of that spark they were never tired of studying, and which seemed so loth to reveal its powers to them. Looking back to the records of laboratory experiments, we can see how they might have parodied Dante, and said:—

". . . this is the spark which spreads
To vivid flame, and, like a star in heaven
With splendour dight, o'er me effulgence sheds."

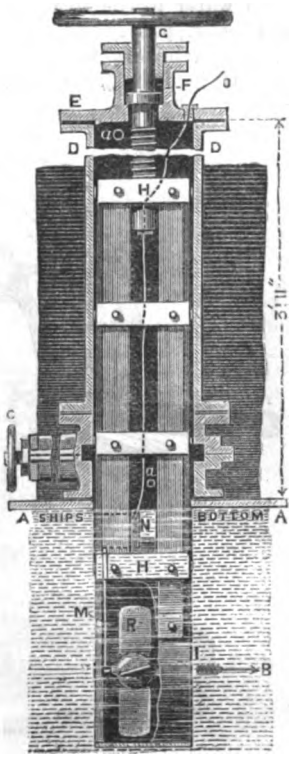
It will not be long now before the visitor to the Palace will be able to see and judge for himself whether the possibilities of the electric light have been discounted at too high a rate of interest. He will see how it can be arranged to give from two, to two thousand candle-power. He will see that the turning on or off the light is accomplished as easily and similary to the turning on or off the gas. Further, he will see also that the amount of light from a lamp can be varied at will within a considerable limiting range. We do not, however, intend to discuss the electric light at the Palace in full in this issue, our intention is only to say that visitors can now see in action and compare many of the best known systems.

Last Saturday some interesting experiments in telephony were shown by Major Flood Page, the managing director of the Palace, at his residence. His house, Ribblesdale, is some three-quarters of a mile from the organ-loft at the Palace, with which it was telephonically connected. Colonel Gouraud's residence, a mile and a half in the opposite direction, is also connected with the Palace. We understood that the transmitters were connected within the organ. It is needless to say that the music was distinctly heard by the listeners at the several telephones. That such a transmission of musical sound is possible is well known. The particular attention of the visitors, however, was directed to the fact that, while the wires were carrying the sounds of the organ, it was possible at the same time for Colonel Gouraud and Major Flood Page to converse over the circuit. Conversation was carried on, the voices being heard distinctly. Unless our recollection is at fault, we think some of the visitors at the recent "telephonic hearing" of the "Mascotte" noticed the phenomenon. It is, however, new to most people. Students of those branches of science, "Sound" and "Electricity," will understand how it is that the telephone is such a remarkably multiplex sender and receiver. We to-day shall merely record the phenomena, and proceed to notice a few of the miscellaneous exhibits, which deserve prominence, in so far as the exhibitors were among the first to be ready.

Kelway's Electric Log.

Although few of the stands are completely ready, and much work has yet to be done before the electric light will be seen in its glory, it is possible to find interesting objects of study in the articles exhibited at the Crystal Palace. We have from time to time noticed the introduction of electricity into new fields, but we do not remember to have described its application to register the speed of ships. This, however, is an application of Mr. Kelway in his Electric Log. It is well known that an accurate record of the distance through which a ship has run, is an object which many inventors have tried to obtain, but we doubt if any has hitherto been perfectly satisfied with his work. Mr. Kelway, however, thinks he has solved the difficult problem, and that by an application of electricity he has obtained the means of saving a vast amount of labour as well as having a trustworthy instrument. This log provides for the continuous registration on dials placed in the captain's cabin, chart room, engine room, &c., showing on each the distance run. In order that the condition of the log should be known, an arrangement is made to sound an electric bell every one-eighth of a knot. If the sound is not given the officer on watch would know that the log had fouled or was otherwise out of order. The position in which the log is placed is said to obviate many inaccuracies which arise in the use of other logs. In Fig. 1, A A shows the bottom of a vessel

FIG. 1.



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supposed to be going in the direction indicated by the arrow B. C is a sluice valve bolted to the bottom of the vessel, shown open, and allowing the sea full access to the iron box D. The iron box D is bolted to the upper flange of the valve C, and is closed at its top by the metal plate E, which effectually pre-

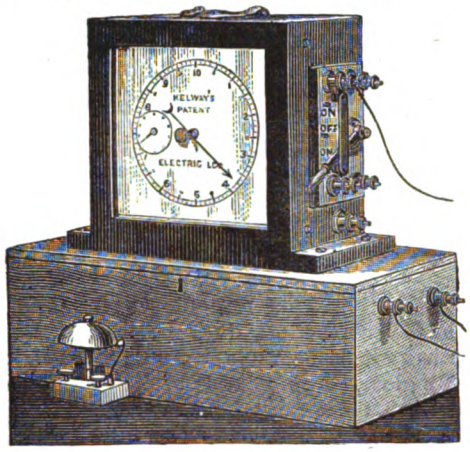
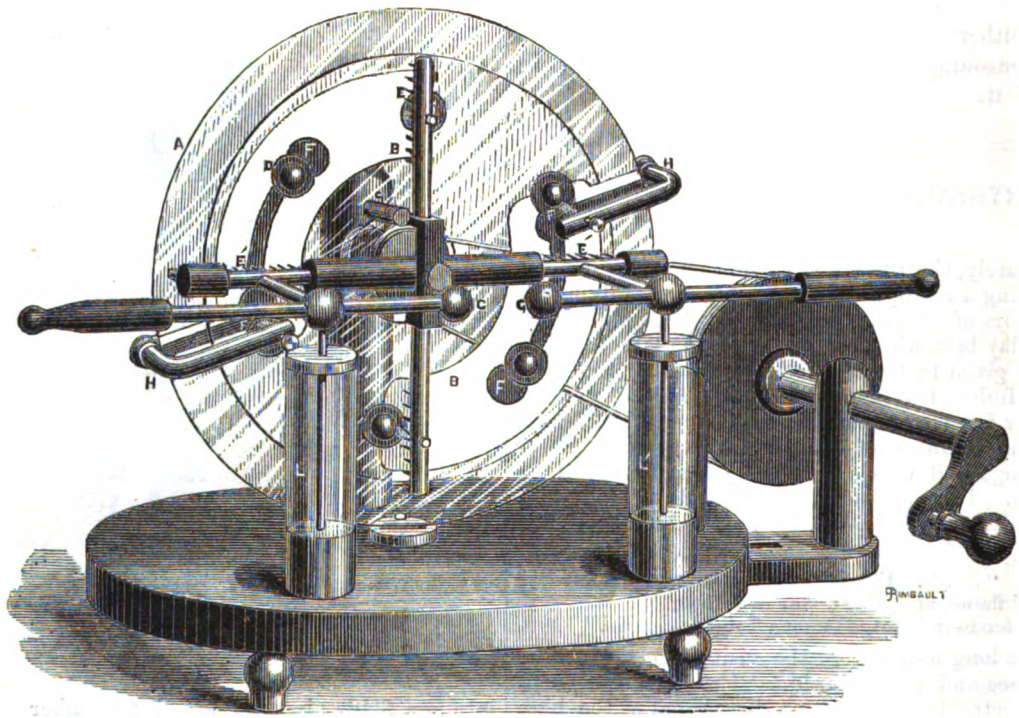


FIG. 2.

vents the ingress of water to the ship's hold. Through the stuffing-box F, in Plate E, passes the metal rod G, the screw-thread on which raises or lowers the metal case H. To the bottom of the cage H is affixed the cylinder I, having its opening for the passage of water in a fore and aft direction, or in a line with the keel of the vessel. The passage of water through I causes the screw R to rotate with the spindle L. On the spindle L is an endless screw which revolves, by the intervention of a wheel, the vertical spindle M, which in its turn actuates a series of wheels in the box N. The last of these wheels (termed the "mile" wheel) makes one revolution while the vessel passes through the water one nautical mile. On the spindle of this "mile" wheel is affixed a second wheel having eight rachet teeth, and these teeth, by moving a lever, cause an electric circuit to be completed—obviously eight times in the mile, the current passing through the electric cable O, to the indicating dials and bells. Fig. 2 shows the dial, which has eighty graduations on the outside circle, and, as the pointer in front of the dial jumps one graduation at each completion of the electric circuit, one revolution of the larger pointer represents ten miles. Ten revolutions of this pointer cause the small one to make one revolution—recording 100 miles. In effect, the mechanism of this improved form of log, is similar to that used in the towing log, to which the inventor's electrical apparatus was affixed, and which was successfully tried on board Her Majesty's ships, "Shah," "Thunderer," "Serapis," "Iris," "Alberta," &c., after reference, by the British Admiralty, to the late Mr. William Froude, F.R.S., who favourably reported on its merits.

Voss's Electrical Machine.

The teaching in our schools is confined almost entirely to "statical electricity." Why this should be so it is difficult to understand. The phenomena are not so clearly and directly connected with the practical applications of electricity as those of current or voltaic electricity. Although the case is as we have stated, the laws of statical electricity are not well understood. The instrument of M. Voss, whose agents in England are Messrs. F. E. Becker and Co., is intended to be used in illustrating the phenomena of statical electricity. It is somewhat similar to the Holtz machine, as will be seen by the illustration. The apparatus consists of a large fixed glass disc A, and a smaller rotating glass disc actuated by multiplying gear as shown. On the front face of A are four tin foil discs, F F F F, connected in pairs by strips of tin foil. Each pair is also connected by a strip of tin foil to the bent arms, H H. These metallic arms H H each carry a light metal brush turned towards the revolving disc, and arranged so as to just touch metal buttons on it without touching the disc. At the back of the fixed plate are pasted two paper armatures. On the face of the rotating disc are attached at regular intervals six tin foil discs D, about an inch in diameter, four of which in certain positions of the plate correspond with the four discs on the fixed plate as shown. One of the metal buttons above mentioned is fixed on the centre of each disc, and, as has been said, is just touched when revolving by the brushes on H H. The collecting combs E' E' are insulated from each other, being fixed on an ebonite bar, and connected respectively to the discharge-terminals C G. The distance apart of these terminals can be varied at pleasure. A vertical brass rod carries brushes at each end similar to, and for a purpose similar to, those on H H, as well as teeth.



Voss's Electrical Machine.

For the theory of this and similar machines, we must refer our readers to Maxwell's "Electricity and Magnetism," Vol. I., pp. 294-5-6-7, or to Prof. Jenkins's work, chap. XIX. It is claimed that Voss's apparatus is but little affected by moisture, and that the effects required can be obtained at almost any time, and regardless of atmospheric conditions.

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THE INSTALLATION OF THE EDISON LIGHT.

In our issue of Jan. 7th we gave a plan of the streets in New York the buildings in which are to be lighted by the Edison light; and on Jan. 21st we gave an illustration showing a longitudinal section of the producing establishment at New York. We now continue our illustrations of this installation. Fig. 1 shows a part plan of engine floor. It will be noticed that from the two wheels two belts are taken to drive two different dynamos. The belting arrangement is shown in Fig. 2. The transverse section, Fig. 3, through boiler rooms should be studied with the previous illustration on page 157. Fig. 4 shows the method of arranging the dynamos in the machine room. This room has been planned to receive smaller dynamos than the one erected in Holborn, but it may happen that before the final touch is

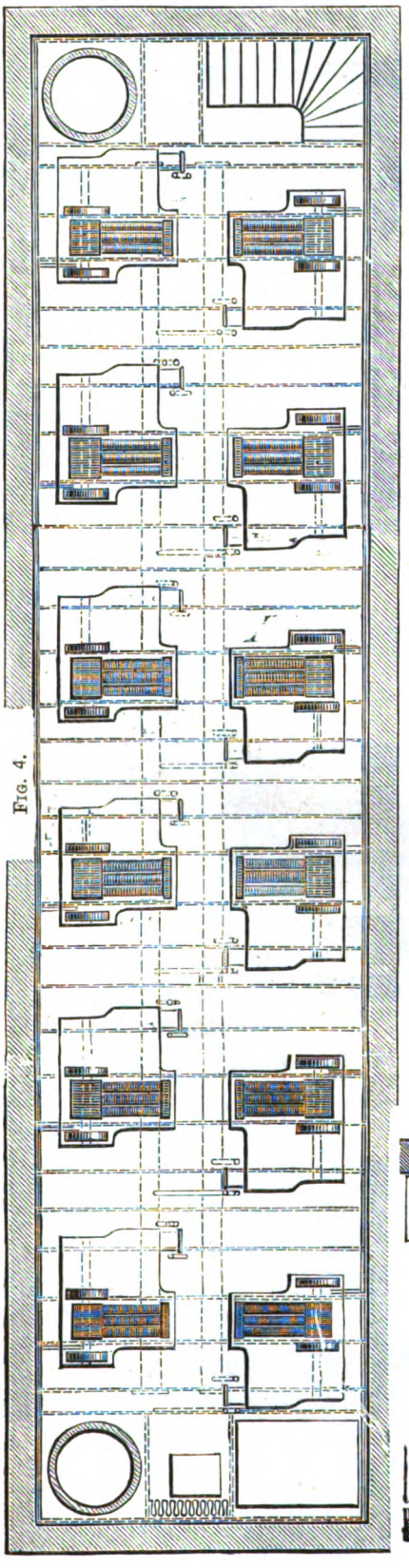

Fig. 4. PLAN OF MACHINE ROOM

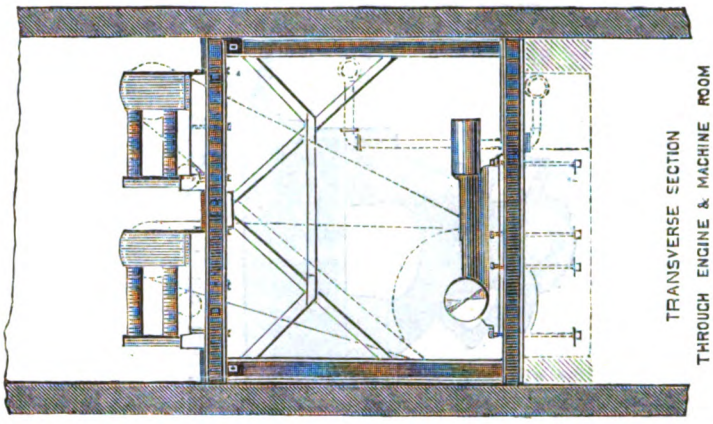

Fig. 2. TRANSVERSE SECTION THROUGH ENGINE & MACHINE ROOM SHOWING DRIVING BELTS

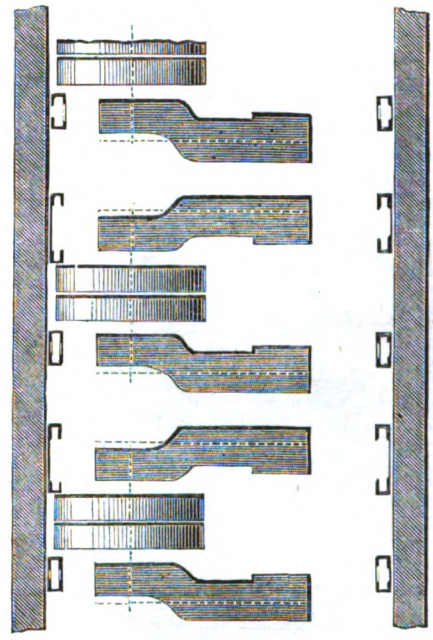

Fig. 1. PART PLAN OF ENGINE FLOOR

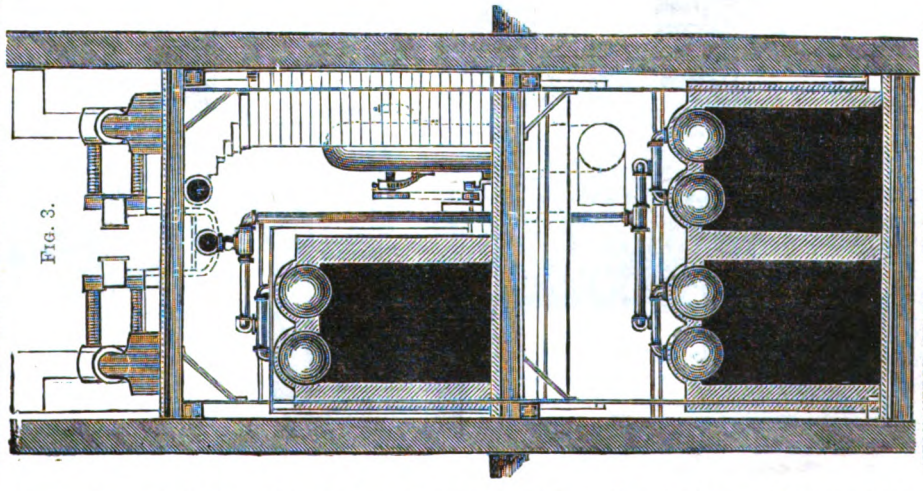

Fig. 3. TRANSVERSE SECTION THROUGH BOILER ROOMS

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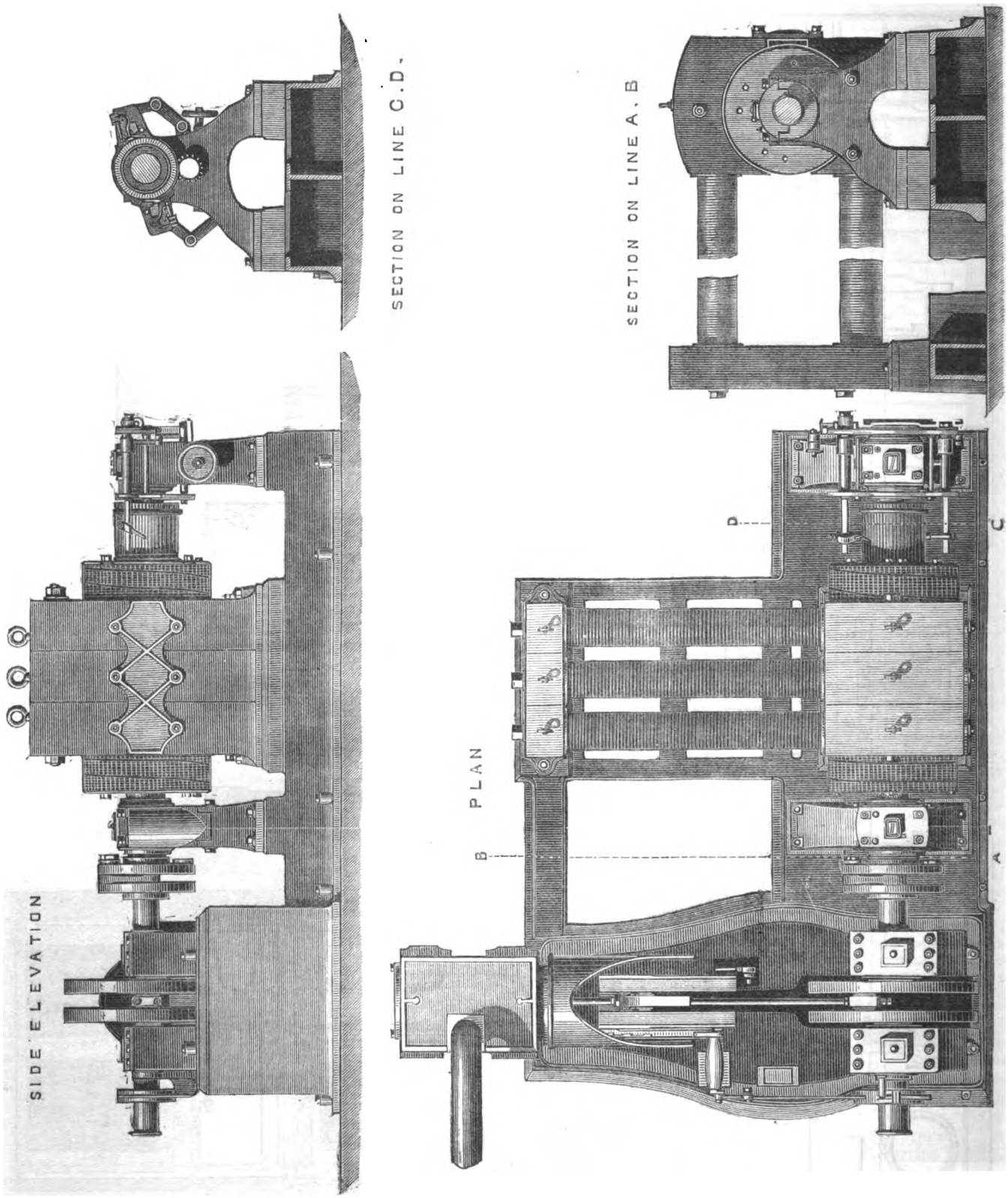
given to the arrangements a less number of machines of the improved form will be used. The illustrations below show the dynamo, as designed for the work in New York, and almost explain themselves. It will be seen that the engine is connected directly to the dynamo. The details will be given in our next issue, when illustrating the machines at Holborn. We may here say that the Edison light arrangements at the Crystal Palace are almost completed. The concert room is admirably lighted by a central lustre, together with a series of lamps hung around the room. In the small room appropriated to the Edison exhibits is also a magnificent central lustre, which has been specially designed and made by Messrs. Verity Brothers. The arrangements at Holborn for the lighting of the streets and buildings adjacent are so far complete, that as soon as the second dynamo is ready the lighting will commence. This second dynamo is in case of accident to the first, either of them being calculated to give the whole current required for the lamps.



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ELECTRICITY AND GAS *VERSUS* SMOKE.*

(*Continued from page* 173.)

The discovery which lies at the root of all the recent agitation and excitement about electric application is not a recent one—nothing more recent, in fact, than the observation of the electric light by Sir Humphrey Davy at the beginning of the century, the discoveries of Œrsted, Arago, and Ampère in electro-magnetism, and the discovery by Faraday of magneto-electric induction in 1831. It is noticeable that the Paris Electrical Exhibition, the triumph and apotheosis of magneto electricity, should have been held precisely in the jubilee year of its discovery. What has been done since then sums itself up as a series of inventions, constituting improvements in the practical methods of utilising Faraday's discovery concerning the generation of electric currents; and among the most important of these inventions I must put the electric motor, devised by Dr. Antonio Paccinotti in 1860. This is the father of most of the dynamo machines of the present day. But Paccinotti did not make it into a practicable machine for producing currents; this was not done for long afterwards—not until the self-exciting principle had been discovered did the Paccinotti motor of the laboratory become the Gramme machine of the workshop.

Meanwhile various machines, Pixii, Clark, Saxton, &c., all more or less inefficient, had been devised, and were in common use, the only really powerful and compact ones being those involving the Siemens armature. But as soon as the idea of the circular commutator and the continuous action of the Paccinotti machine was made public and evident by the success of the Gramme, it was perceived that a slight change in the old Siemens armature would make it as good as, or if not better than, a Gramme ring.

[Slides and diagrams of the various machines were exhibited, from the original copper disc rotating between the poles of a magnet, upwards.]

Wall-sheet.....	Faraday, first machine.....	1831
	Siemens armature	1857
	Paccinotti ring	1860
	Self-exciting or dynamo principle ...	1866
	Gramme machine.....	1871
	Siemens machine	1875

Since the last date the number of machines invented is very great. The Brush is very like the old Paccinotti machine, the Burgin and others are modifications of the Gramme, and Edison's gigantic machine is based on the principle of the Siemens. The machines of De Meritens, Lontin, the alternating machines of Siemens, Gramme, and others, are improvements on the old Pixii idea, and have advantages of their own.

[At Liverpool a couple of A Grammes, driven by a 14 h-p. steam-engine at the back of the Picton Reading Room, were coupled in series, and their current brought into St. George's Hall, where the current produced some striking effects, such as making magnets, burning up nails, &c. The arc was over an inch long.]

These, then, are the machines, and this the method for generating electric currents, and which for power and economy throw the old voltaic battery completely into the shade. Now, then, what is to be done with the current? First and foremost we must use it to generate light.

On this part of the subject I shall not dwell, because the production of light has never been a smoky operation, and, therefore, it does not properly belong to my subject. But though gas produced no smoke, it produced carbonic acid and great heat, and it consumed the air of the room in which it burnt. All these were great and serious disadvantages from which the electric light is entirely free. From the electric light the gases evolved are slight, and from the incandescent lights *nil;* the heat produced is small, and the air consumed is nothing. Not only this, but the colour is so much more perfect than gas that artists will be able to continue their labour in the evening instead of waiting for the brief interval of white daylight which in an ordinary winter one is favoured with in London.

I have heard people say the electric light is blue and ghastly, and that it fizzes and jumps. I would reply very good; I can make a gas flame burn blue and ghastly, and jump and roar. But that is not the normal condition of a gas flame; and if your gas does that you know that something is wrong, and you send for somebody and blow him up. Just so with electricity; if the arc is too long it will be bluish and many-coloured, if the engine is too weak or badly governed it will jump, if the lamp is ill-adjusted it will fizz, and if the carbons are bad it will dodge about and spit. In any of these cases send for some one and and relieve your mind. These things ought not so to be.

I know a shop not fifty miles from St. George's Hall where the electric light does all these things; but you go into the Picton Reading Room. I have been there several times for a few minutes, and I must say that while I was there I never heard a fizz and never saw a jump. I don't say that even that is perfection; it will be improved on no doubt, but it is pretty good for our present stage. And if anyone tells me that that light is blue, I shall expect him in the next breath to tell me that I am green. That gas-light is yellow—a sort of dirty orange—you can see its colour by daylight.

But I must not leave the subject of electric lighting without referring to the subject of the incandescent light, which in its present form is so beautiful and so vastly superior to everything of the kind known before that it almost constitutes a discovery, and ranks quite above the mere observation of the original arc light.

It seems to me that very great credit is due to the pioneers in the development of incandescent lamps, Mr. Swan and Mr. Edison, the latter of whom worked on in the face of most extravagant puffing on the one hand and contemptuous ridicule on the other until he had completed his system. I think it is an open secret that many, if not most, scientific men were dead against any system of lighting by incandescence, as being necessarily extravagant; but it is now found that, with the present lamps, this charge is unfounded. They can hardly yet be called economical, but they are not extravagant. The semi-incandescent lamps of Werdermann and Joel I do not here refer to. They are very likely useful enough, but they are mere modifications of an arc lamp so as to use an infinitesimal arc, and they do not involve any new and ingenious process like the manufacture of the vegetable carbon filaments and the sealing them in exhausted vessels. The perfection of these lamps, again, is due in great measure to the splendid vacua we can now get, and in this matter Dr. Sprengel, Mr. Crookes, and Mr. Gimingham can each claim a part. [A set of thirty Swan lamps were beautifully lighted by the current from the two dynamos coupled in series, and specimens of the Maxim lamps, too, were shown. The methods of turning the lamps up and down, and of replacing broken ones from the store cupboard was also explained.]

The improvement in lighting, however, is but a small portion of the coming change; it is a very pleasant portion, but what will be its effect upon the gas companies? Upon them it will have the very best effect; it will stir them up, awake them out of their lethargic pocketing of dividends, and make them look about and see what is left for them to do. A great part of the lighting will be taken away from them, gradually, let us hope, but certainly—that they may make up their minds to. But will there be nothing else left for them? Why certainly; pretty nearly the whole of the heating, and a great part of the power producing. I believe that we have only begun to use gas. It has a most important part to play in the future, but we have never used it properly. Gas is a *fuel*, and burning fuel is a feeble way of generating light. It is the very best way of producing heat, though, and a very good way of getting power.

Now, why do I call gas a fuel? I do so because 95 per cent. of ordinary gas is heating gas, and gives no light whatever; it is only the remaining 5 per cent.* that consists of light-giving hydro-carbons, and they give heat as well.

Except that gas is very cheap, it would be a fearfully extravagant method of obtaining light.

When I say that gas is very cheap I don't mean so much that it is supplied very cheaply, but it is produced very cheaply from that dreadfully cheap substance, coal.

Let us begin to think of gas as a fuel instead of an illuminating agent, and see what uses open out for it.

Our universal method of obtaining domestic heat in this country is the open coal fire, and what I want to inveigh against and to see altered is this burning of crude coal as it comes from the pit. To shovel a heap of coal together is a simple plan of making a fire—a very simple plan; it is what one would expect of a savage—it would be highly creditable to an ape. To us in the present day it is disgraceful barbarism, and I hope that when the process of extermination has once begun, it will go on with great rapidity. It is a troublesome process, a wasteful process, a dirty process, and is, really and truly, an expensive process.

Think what a coal fire means. First, it means the carting of a lot of coal about the streets. This eternal carting about of things in the streets costs no mean sum per annum, and it is labour that could well be spared both for men and horses. Then it means the dirty operation of storing it away in the coal cellar. Then it means the carrying it about the house, and a coal scuttle

* A lecture delivered by Professor Oliver Lodge, partly at the London Institution and partly at St. George's Hall, Liverpool, in December, 1881.

* This percentage rises as high as 13 for cannel coal, but for quite common coal it is as low as 3.

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in every room. Then the use of wood and paper for lighting a fire—a sufficiently unpleasant operation.

Then comes the smoke. Out into this limited air of London go the smoke and sulphurous gases, and ammoniacal liquors and every other product of destructive distillation that in their proper places are of great value, but which, let loose in the atmosphere, are pernicious poison. If a little smoke comes out into the room people cry out and think it a fearful nuisance. Make it a maxim that anything which is unpleasant when it escapes into a room cannot be good when turned into the air. If you live by yourself on the top of, say Vesuvius, or even Snowdon, you may be permitted to make a lot of smoke if it amuses you, but when four million people live together and each takes to manufacturing smoke at the rate of three or four fires a house, the aggregate result is unspeakably horrid. A gas fire would have not one of these evils; the products of complete gas combustion are not wholly unfit to escape into a room, therefore there is no objection to turning them loose into the common air. But we have not done with the evils of a coal fire yet. It wants looking after or it will go out. Persons who get absorbed in their occupation must, I am sure, often have occasion to anathematise their study fire, which keeps recalling them to the level of everyday existence. Then there are the ashes which have to be swept up, collected, and ultimately carted away again. I often think that the clearing out the grates, and laying the fresh fires every morning must be one of the most unpleasant parts of a housemaid's occupation. Finally there is the smoky chimney, the soot, and the chimney sweep, the reminiscence of whose graceful presence will be handed down to our grandchildren as something unfamiliar and grotesque.

Against all this is to be set the cheerfulness, the ventilation, and the poking, which an open fire secures. Many grown people seem to fancy that poking a fire is a pleasure, but really I think it must be a pleasure that's almost pain. Does it never pall after frequent repetition? If not, then let us have a toy coal fire at our country retreat and poke it all day during the holidays. Oh, then, you are inveighing against the open fireplaces, and want us to have stuffy German stoves. No, I do not. We English like an open fire, we like standing in front of it, and toasting ourselves at it; and we can, as a rule, afford to pay for the luxury. Then let us stick to the open fire by all means. It is very cheerful, and it ventilates the room well. I don't care whether a fire is open or shut, or both, or neither, all I ask is that it shall not be smoky, and, if possible, not ashy either.

Well, then, you want the common gas fire, which makes bad smells, gives little heat, and costs a ruinous sum. It is quite true that I want a gas fire, but I want one that gives no smell and plenty of heat at a small cost. Is there such a one in existence? Well, that is one of the questions of the present day, and that is one of the very important things that the Smoke Abatement Exhibition, now at South Kensington, may be expected to answer for us.

I think it very likely, and, indeed, most probable, that the gas fire of the future is yet in embryo, but great steps towards it have been made, and it is something to know what it is that we want. As soon as the British public can be made thoroughly discontented with their coal fires, and thoroughly in want of a good gas fire, there can be no doubt that it will be forthcoming.

(TO BE CONTINUED.)

ANSWER TO CORRESPONDENT.

H.P.—A Leclanché battery does very well for working a bell, and generally for use intermittently, but not constantly.

Your second question should have mentioned the time during which the lamp is to burn. However, to work a Swan lamp with a battery is, we fear, a rather expensive luxury, and we should not advise it, except as a laboratory experiment. If you will give more particulars we will advise by letter.

PHYSICAL SOCIETY.—JAN. 28.

Dr. Stone in the Chair.

Mr. C. VERNON BOYS read a paper "On Apparatus for Calculating Efficiency." The object of such machines is to automatically divide and continuously record the quotient of the speeds with which two things are turning. If the two things are the records of two of his integrating machines, one finding work put into and the other work sent out from any combination of mechanism, then the quotient gives the efficiency of the combination. If one measures work or current and the other time or turns of a machine, the quotient measures the value of horse-power per hour or current per turn. Mr. Boys described four machines of the kind acting on two principles, from which he names them logarithm and harmonic dividers. They all derive their action from motions of pure rolling. The simplest is made by hanging a magnetised steel reel on to a pair of iron cones, which are turned by the integrators. The reel travels about, and continuously shows the value of the quotient.

Mr. Boys then read a paper "On a New Current Meter." The rate of a pendulum clock depends on gravity, and is proportional to the square root of the strength of gravity. The rate of a watch depends on the strength of the hair spring, and is proportional to the square root of the strength of the hair spring. The force due to a current passing through any combination of wires and iron is proportional to the square of the current strength. If, then, any of the parts are so arranged that they are capable of vibrating under the influence of the electro-magnetic force, the speed of vibrating will be simply proportional to the current strength—*simply* proportional because the square of the speed measures the force, and the force is proportional to the square of the current. If, then, such a contrivance takes the place of the balance or pendulum of a clock, the clock will measure electric current amount instead of time. In order that the indications should be true, either the maintaining power must be so contrived that the amplitude does not vary much, in which case it does not matter what is the law connecting the force with the displacement, or the parts must be so arranged that the force is directly proportionate to the displacement, in which case it does not matter what the amplitude is. The two important points, therefore, are the controlling and the maintaining power. Mr. Boys showed several ways of producing a controlling power. In the first, which is a combination of two solenoids, one moving through the other, the force will, if they are properly arranged, be proportional to the displacement. Here, there being no iron, the action will apply to the case of alternating currents. In another case a small armature is mounted on the balance staff, and around it are the two poles of an electro-magnet, which forms part of the circuit. Another form is unaffected by residual magnetism. In it two crescent-shaped pieces of iron, forming the sides of the balance, pass through two fixed solenoids. In all these cases the direction of the current is of no consequence. The maintaining power may be an ordinary escapement driven by clockwork in the usual way. In this case the amplitude will be less with a stronger current, but this may be overcome by the use of an electro-magnetic remontoire. The maintaining power may be independent of clockwork, an impulse being given electrically at each swing of the balance. Mr. Boys showed a meter made on this principle, in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is diverted through secondary solenoids when the balance is in its neutral position, at which time a variation in the currents in the controlling solenoids has no effect in disturbing the period of an oscillation. To regulate meters of this class a weight is screwed outwards or inwards, according as the meter goes too fast or too slow. As this meter depends on dynamical principles alone, and is independent of gravity, it must work equally well on the moon or elsewhere, an advantage which the meters previously described by Mr. Boys do not possess.

Professor JOHN PERRY remarked that Mr. Boys' devices were very promising, and mentioned that Professor W. E. Ayrton and he had invented a new current meter, which was very simple in its action. This apparatus, which the authors term a "Farad-meter" will, we understand, soon be made known.

Professor GUTHRIE observed that Mr. Boys' meter had the advantage of doing practically no work, and taking little or no power from the current.

EASTERN TELEGRAPH COMPANY (LIMITED).

The nineteenth half-yearly general meeting of this Company was held on the 2nd instant, at the City Terminus Hotel, under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. George Draper) read the notice convening the meeting and the minutes of the last meeting, and the report of the directors, which has been published in *The Electrician*, was taken as read.

The CHAIRMAN, in moving its adoption, stated that the revenue for the half year ending 30th September last had been £282,834, or £14,706 more than in the corresponding period of 1880; the ordinary expenses had been £67,498, a decrease of £541, notwithstanding that in the half year under

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review the following items had been included, which did not appear in the accounts of the corresponding period :—£715 for duplex apparatus, £1,578 for staff insurance, and £505 in connection with the earthquake at Chio. Unfortunately, the cost of their repairs had been very large—£47,228—which was nearly equal to a dividend of 1¼ per cent. on their ordinary capital. That amount was as compared with £30,476 in the corresponding period. These large expenses were owing to their ships having been constantly employed on repairs and other works. Of the amount he had mentioned, £13,340 was for new cable. During the half year their ships had encountered considerable danger, and had sustained much damage. The general expenses in London had amounted to £6,521, being £58 more, net, there having been decreases and increases in certain items. The same remark applied to the working expenses at stations, which had been £47,418 in the half year, or a net decrease of £2,199. After giving particulars of other items of expenditure, he referred to the duplex apparatus, and stated that it had cost them £15,065 on capital account. In future, however, such expenditure would be charged to revenue, and in that mannner £713 had been charged in the past half year. Since their last meeting they had lost by death the valuable services of Colonel Glover and the Right Hon. W. N. Massey, M.P. They had carefully considered the future working of the Company, which required a great deal of personal and daily attention, and, looking at the peculiar character of the work to be done, they had decided to elect two younger men to the vacant seats, that they might acquire a thorough knowledge of the working of the institution, and be able to undertake the more important work which would come on them in later years. In that way they had appointed Lord Sackville Cecil, who, he unhesitatingly stated, was one of the eminent electricians of the day, and who had had considerable experience of cable laying. The other young member was a son of his (the Chairman's). Six months ago they were informed of the death of a son of his in the service of the Company, who had been introduced with the view of aiding to a certain degree Sir James Anderson. His son whom the directors had now appointed to a seat at the board had had considerable business experience, and he hoped he would be able, as it had been intended that his elder brother should, to devote his best services to the interest of the Company. As he had stated, their repairs had cost them a considerable sum. It had been sometimes said that the "life" of a cable was ten years, and their cables were now about ten years of age, but they believed at the present moment, judging from the cable they had taken up, that generally their cable was pretty well, so far as the core was concerned, as sound as on the day it was laid. He believed with what they had done that they might look forward with more certainty to the next ten years than they could in the first ten years of their existence. There was no question at all now that they had their property in hand. They knew if a cable broke they could repair it, as shown by the following telegram which they had received that morning from the ship "John Pender," which was now at work on one of their cables in the Bay of Biscay :—"Corunna, 8:35 p.m., 1st February, 1882. Since leaving port grappled for the cable north of the only position where it had yet been hooked. Caught it in lat. 44:5, long. 9:1, on the 28th, and picked up towards the fault; but after four and a-half miles had been recovered, the weather rendered it necessary to cut and buoy. Returned to the buoy on the 30th, and picked it up, but our moorings parted. The latitude, however, of the East and West line being then rendered more precise, several sweeps were made further East, and last night the cable was hooked nearly half a mile west of the fault, in lat. 44:10, long. 8:50. The fault was a chafe, 360 fathoms. The depths are very irregular, and bottom rough in places. Now blowing easterly gale, with high sea." If they had fair weather he hoped that the repair would be effected in forty-eight hours time; and he would remind them that there was a time when it was considered an impossibility to repair a cable in the Bay of Biscay. They had always endeavoured to maintain friendly relations with all Governments concerned in the Mediterranean and the Levant. They had just concluded an arrangement with the Greek Government, he believed, to connect all the Greek islands with the main system. This would be a considerable feeder to the Company's existing lines. They had made arrangements with France as to their Algerian and other traffic. They had also had threatened opposition from France as to Egypt, but he believed that that was now at an end. Their relations, too, with regard to Turkey were of the most satisfactory nature; and so with respect to Italy, with whom they were now negotiating for certain extensions, and the working of certain submarine systems. It was of the greatest possible importance that the Company should hold their position in the Mediterranean and the Levant; and he now had to mention, on that, what was a matter of some delicacy. Austria, like France and other nations, had been very anxious to have a communication of their own with Egypt. They had tried twice, and the Company had succeeded in keeping the thing in their own hands. Now, however, Austria had granted a concession which he was glad to say was in friendly hands—he referred to the Telegraph Construction and Maintenance Company. That Company had made the cable, and the Eastern Company were in negotiation now to secure that cable as part of their own system. The cable was from Trieste to Corfu, where it joined the system of the Eastern Company, and he believed that it would be satisfactory to the Austrian Government that this Company should have the working of that cable. There was some jealousy regarding questions of competition and monopoly, but he hoped they would obtain the cable referred to in a manner that would prevent jealousy, or the statement that they were trying to become great monopolists. They were no doubt monopolists in these waters, but having regard to the reductions which the submarine telegraph companies had made, and the enormous benefits they had conferred, comparing this with what had been done by our own Government in the last ten years as regarded the land lines, the result was marvellous. Notwithstanding what the companies had done, they had still maintained a steady, respectable dividend. Before any conclusion was come to as regarded the Austrian cable, they would call a special meeting, and lay the whole question before them. Next year they had £232,000 of 6 per cent. debentures maturing, and it might be necessary to have a reissue, but he hoped at a considerably lower rate. There had been a good deal of correspondence in the newspapers with regard to the interruptions to which the companies were subjected in the laying, and particularly the repairing of their cables. These companies had now property of the value of 27 millions, and they had taken up such a position—commercially, politically, and socially, that they had become indispensable. He was glad to say that our Government had taken up this question with the view of making it of an International character. Germany had seconded their efforts, and France and Spain had approved them. He was, therefore, now hopeful that their property would have a certain amount of security by some law of an International character, by which they would be freed from obstructions in carrying out repairs, and enabled to recover damages for malicious injury to their cables. He then moved the resolution.

The Marquis of TWEEDDALE having seconded the motion, a discussion followed, in which Messrs. Marks, John Newton, William Abbott, Griffith, Roberts, and Colonel Leslie took part.

The CHAIRMAN fully replied at the close of the discussion, and referred to the advantage of the arrangement they had made respecting the South African cable, which he believed would ultimately become the property of this Company without having cost them one shilling. With regard to Mr. Newton's criticisms on the constitution of the Board he was content to refer to what they had done for the Company, and to the management which had brought about the results achieved. He was happy to state that in the current half year their returns had been the best they had ever had. He next spoke of the importance of a large reserve fund; and stated with regard to the issue of any new capital that the shareholders would have the first consideration by the directors as to its allotment. The report was then unanimously adopted.

On the motion of the CHAIRMAN, seconded by Sir J. ANDERSON, the Marquis of Tweeddale was re-elected a director, as was also Mr. G. Garden Nicol, on the motion of the Chairman, seconded by Mr. Newton. The retiring auditor, Mr. Henry Dever, was also re-appointed.

Mr. ABBOTT then moved, and Mr. NEWTON seconded, a cordial vote of thanks to the Chairman and directors, and the former gentleman assured the Chairman of the satisfaction which the shareholders had in seeing him among them so completely restored to health.

The CHAIRMAN briefly acknowledged the vote, and warmly recognised the confidence reposed in them by the shareholders.

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Feb. 1.		Business Done Week Ending Feb. 1. Highest.	Lowest
Anglo-American	49,	50	51¼	48¼
Do. Preferred	77,	78	79	77
Do. Deferred	21,	22	22¼	21
Brazil Submarine	11,	11¼	11¼	11¼
Cuba	8¾,	9¼	9¼	8¾
Do. Preference	16,	17	17¼	16¼
Direct Spanish	5,	5¼	—	—
Do. Preference	14¼,	15¼	14¾	14¼
Direct United States Cable	10¼,	10¾	10¾	10¾
Eastern Telegraph	9¾,	10¼	10½	9 15-16
Do. 6 per Cent. Preference	12¼,	12¾	12¾	12¼
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	10¼,	10¾	10¾	10¼
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust Company.	6,	6¼	6¾	6 1-16
Do. Preference	12¼,	12½	12½	12¼
Great Northern	11¼,	11¾	12	11¼
Indo-European	28,	29	28½	28¼
Mediterranean Extension	2¼,	2¾	2½	2¼
Do. Preference	9¼,	9¾	—	—
Reuter's	12¼,	12¾	—	—
Submarine	270,	280	—	—
West India and Panama	1¼,	1¾	1¾	1¼
Do. 1st Preference	7¾,	8¼	7¾	7¾
Western Brazilian	8¼,	8¾	8¾	8
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1½	1 9-16	1 5-16
Oriental	⅞,	1	9-16	9-16

ELECTRIC LIGHT.

Electric Light and Power	1,	1¼	1 5-16	1¼
Anglo-American Brush	9,	9½	9¾	9¾
United Telephone	11¾,	12¼	13¾	11¾

TRAFFIC RECEIPTS FOR JANUARY, 1882.

Companies.	Jan., 1882.	Jan., 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,800	2,527	273	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,129	29,434	3,695	—
Eastern Telegraph Company	53,648	47,445	6,203	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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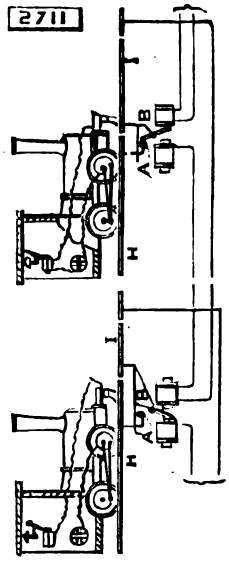
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2711. Improvements in Electric Danger Alarms and Signals and other Safety Appliances for Railways, *T. A. Burtis Putman, New York, 21st June*, 1881. 8*d*.

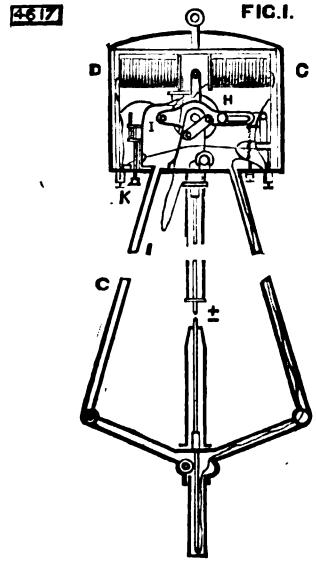
The object of this invention is to provide a means for warning the driver of an engine when he is too close to another train. The engine is fitted with an electric generator, an alarm apparatus, and a metallic brush which sweeps the rail and forms connection with it and with the alarm



apparatus on the engine. The generator is connected with the alarm apparatus, and also with one of the wheels of the engine. In ordinary running a closed circuit is maintained on the locomotive and the alarm is not sounded; whenever the circuit is broken the alarm is operated. The rails are divided into insulated sections, connected as shown in the figure, from which it will also be seen that if two engines are on the same section of the rails the alarm apparatus will at once be operated through the relays. When B is in contact with A, that is when the line ahead is clear then the circuit is completed with the exception of the break between rails H and I, and this is done by the brush and the front wheel as the engine passes, and the circuit is not broken. But if B be away from A, that is when there is danger ahead, then the circuit is broken at A B, and when the left-hand locomotive bridges the gap between H and I with the brush and the front wheel, the circuit is broken and the alarm operated. The invention also includes an arrangement whereby if any points remain open that should be closed an alarm will be given to the driver on the nearest section of rails; in the same way should the points be closed and the signalman try to open them, a disc will indicate to him that a train is on that section of rails. In combination with the alarm on the engine is an arrangement for marking off on paper kept in constant motion the times at which alarm signals were received on the engine.

4617. Improvements in Electric Lamps, *A. M. Clark*.—*21st June*, 1881.—(*A communication from H. B. Sheridan, Cleveland, U.S.A.*) 6*d*.

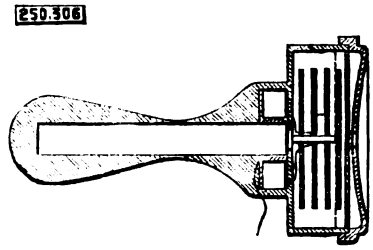
The regulation of the carbons in this lamp is



effected by the pulley H and the chain C, which is attached to the ends of both carbons. When the current is on, the core E is attracted by D, and caused to enter it. This action moves the lever to which E is attached forward, and causes a plate to press on the spring I, which in turn presses upon the pulley H, and causes it to revolve and wind up the positive carbon a short way by means of the chain, the same movement also lowering the negative carbon and establishing the arc. When the arc becomes too long, and the resistance is thereby increased, the current through D becomes lessened, and that through G increased when the core E is attracted into G and the converse of the above takes place. The tension of spring I can be regulated at will by K, as will be seen.

250,306. Receiver for Telephones, *Henry E. Waite, Bridgport, Conn., assignor to Charles F. Livermore, New York, N.Y.—Filed May 23rd*, 1881.

Claim.—(1) In a telephone receiver, a magnet projected within and in combination with the cup or hollow chamber, to which the diaphragm and carpiece are secured, said magnet being provided with thin magnetic discs, and a coil arranged within said cup, substantially as described. (2) The combination, with the cup or sound-chamber, of a magnet projected within said chamber, magnetic discs forming flattened extensions of the pole



thereof, and a coil or helix arranged between the discs and within the receiver cup, substantially as described. (3) The combination, with a hollow metal cup of a receiver, of a bar-magnet, projected within said cup, magnetic metal discs secured thereto, a coil arranged between said discs and within the cup, and a second coil arranged upon the magnet outside the cup and connected with the inner coil, substantially as described.

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SLIP

THE TELEPHONE IN BRITISH COLUMBIA.—The telephonic system is a grand success in Victoria.—*Colonies and India.*

AN ELECTRIC TRAMCAR IN BRUSSELS.—It is stated that an electric tramcar will shortly be introduced on the Brussels tramways.

ROYAL INSTITUTION.—Dr. W. Bowman has been elected hon. secretary, and Mr. Warren De La Rue manager of this institution.

ELECTRIC LIGHT FOR EASTBOURNE.—It is reported that a company has been formed to introduce the electric light into this town.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 3rd inst. amounted to £3,845.

THE BELGIAN TELEPHONE COMPANY.—The Compagnie Belge des Téléphones was dissolved on the 9th January. The offices were at Brussels.

ELECTRICAL APPLIANCES MANUFACTURING COMPANY.—The formation of this company is announced, with a capital of £50,000, in £1 shares.

ELECTRIC LIGHT IN MELBOURNE.—The Commissioner of Railways for Victoria has decided to light the metropolitan railway stations by electric light.

TELEPHONE AND ELECTRIC LIGHT COMPANY.—The River Plate Telephone and Electric Light Company has been formed, with a capital of £100,000, in £5 shares.

NEW BOOK.—The first volume of "Leçons sur l'Electricité et le Magnétisme," by MM. E. Mascart and J. Joubert, has recently been published by M. Bertrand of Paris.

INDIA RUBBER, GUTTA PERCHA, &C., COMPANY.—The next meeting of this Company is to be held on Tuesday next, the 14th instant. The report of the directors will be found in another column.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of January, 1882, were £16,960, against £17,353 for the same period of 1881, and £17,297 in 1880.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of January were £2,055, against £1,056 in the corresponding period of last year, being an increase of £999.

SHIP LAUNCH.—It is stated that H.M.'s turret ship "Colossus" will be launched on March 21st. The electric light will probably be requisitioned to enable the launching gear to be set up with extra rapidity.

COALITION.—The Ripon Town Council have been invited by the Birmingham Town Council to join them in protecting the interests of corporations having gasworks under their control against the Electric Lighting Bills.

THE ELECTRIC LIGHT FOR BARNARD CASTLE. — The Local Board of this northern town have instructed their clerk to make inquiries as to the practicability of lighting the town by the electric light, and report to the board.

THE ELECTRIC LIGHT IN SICILY.—It is stated that petitions have been presented to the town councils of the principal towns of this island, such as Palermo, Messina, and Catania, for the introduction of the electric light.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ending February 3rd, 1882, were £2,495, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

ELECTRIC LIGHT IN PARIS.—The newspaper *La Patrie* makes use of over twenty incandescent lamps to light its offices, as well as four Gravier lamps, whilst four of the latter light the street outside. So says a Parisian contemporary.

LONDON-PLATINO BRAZILIAN TELEGRAPH COMPANY.—The revenue of this company for the month of November is estimated at £1,868 (Western Brazilian portion £1,115, Land Lines £753), as against £1,990 for the corresponding period of 1880.

FRENCH MINISTRY OF POSTS AND TELEGRAPHS.—In spite of the recent changes in the constitution of the French Cabinet caused by the defeat of M. Gambetta, M. Cochery still retains the portfolio of Minister of Posts and Telegraphs under the new Administration.

SIXPENNY TELEGRAMS.—At the annual meeting of the Middlesbrough Chamber of Commerce last week, a discussion on the question of the introduction of a sixpenny minimum for telegrams ensued, several members expressing themselves in favour of such a minimum.

FAURE'S ACCUMULATORS IN PARIS.—*L'Electricité* says that the Compagnie Force et Lumière had supplied Faure batteries to two shops in the Avenue de l'Opera, and two others in the Boulevard des Italiens, to provide the necessary current for lighting them by electric lamps.

ELECTRIC LIGHTING AT HAVRE.—The Compagnie des Chemins de fer de L'Ouest has decided to light up that portion of the quays of the Port of Havre over which its sidings run by means of the electric light. The Jablochkoff light, as already in use in other parts of the harbour, will be employed.

THE TELEGRAPH AND THE ARABS.—In a lecture delivered recently before the Victoria Institute Mr. Rassam explained the Arab word "Tel" means "wire," and "Araph" "to know" or "expound;" hence "to know by wire" or "obtain knowledge by wire" is the Arab's explanation of the use of the telegraph.

THE FORTH CABLE.—The new cable across the Forth from Granton to Aberdour, was successfully laid last week by the ss. "Morna," and the old one repaired. On Saturday last this vessel put into Leith for coal and water, and afterwards procceded northwards to repair cables in the Tay and north of Scotland.

THE TELEPHONE AND THE GERMAN GOVERNMENT.—A telegram from Berlin says that the Minister of Posts and Telegraphs has followed the example of the English Postmaster General, and asserted that the establishment of telephonic communication between houses is a part of the Imperial monopoly.

THE CITY COMMISSIONERS OF SEWERS.—At the first meeting of the newly-appointed Commissioners, Mr. Felton, the chairman for this year, said that, "With regard to the electric lighting, he hoped that by the end of the year they would have extended it to all the principal thoroughfares in the east and west districts of the City."

THE PIC DU MIDI OBSERVATORY.—A subterranean cable has been carried up to the observatory established by General Nansouty, on the summit of the Pic du Midi de Begorre, in the Upper Pyrennees, thereby enabling meteorological

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observations to be despatched by telegraph without fear of interruption from the winter storms.—*La Lumière Electrique.*

THE TELEPHONE IN FACTORIES.—The *Kreuz-Zeitung* of Alfed announces that the owners of the Hanoverian paper factories of Alfed and Gronau have established a telephone line between their two factories. The cost of erecting it amounted to 2,000 marks (about £100), and the owners will pay a yearly rent to the Post Office of 50 marks (£2 10s.) for it.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th January are £2,115, as compared with £2,192 in the corresponding period of 1881; and for the half month ended 31st January £2,741, as compared with £2,139 in 1881. The October receipts, estimated at £3,848, realised £3,791.

THE TELEGRAPH IN CHINA.—A Reuter's telegram, dated Shanghai, December 30 (*viâ* San Francisco), says:—The telegraph line from Tientsin to Shanghai has been opened to the public at a moderate tariff. A contemporary states, on the other hand, that, in order to render the telegraph popular, the Chinese Government have given the public the free use of it for a month.

ELECTRIC LIGHT FOR HASTINGS.—A Company has been formed in Hastings with a nominal capital of £50,000 (£10,000 of which will be called up), its object being to introduce the Brush system of electric lighting into that town. The Company has obtained leave from Messrs. Hammond and Co., the concessionaires of the Brush system in Sussex, to work this system in Hastings.

UNIVERSAL ELECTRIC COMPANY.—This is the title of a company which has recently been started in Glasgow. It has acquired a portion of the Baltic Jute Works at Bridgeton, near Glasgow, which will be used as a factory for electrical appliances generally. The Glasgow office is at 58, West Regent-street. Mr. Akester is manager of the works, and Mr. Robert Galt, jun., secretary of the company.

DOLBEAR'S TELEPHONE.—A successful trial was made on Wednesday evening at a *conversazione* at No. 33, Rutland-gate, Hyde Park, W., the residence of Mr. S. Parry, with Prof. Dolbear's telephone receiver, which has already been described in these pages (Vol. vii., p. 171). The transmitter (Hunnings') was some five blocks of houses distant, and the sound of singing and the playing of different musical instruments was distinctly heard.

WATER POWER AND ELECTRIC LIGHTING.—It is stated that M. Lortet, of Lyons, France, has made a preliminary trial of a system of generating electricity for lighting the house belonging to the Faculty of Medicine in that town, by means of water wheels driven by the current of the Rhone. It is also stated that he is endeavouring to obtain permission from the authorities to enable him to permanently establish this system of obtaining power for electric light purposes.

INCREASE OF TELEGRAPH TARIFFS IN AMERICA.—In reference to our note of last week on this subject we are informed that the exact alterations made by the Western Union Telegraph Company in their tariffs for messages are —to increase the tariff on half-rate night messages some 30 per cent. At the same time they have made a slight reduction in the regular day rates, their object being to make both day and night tariffs nearly equal, and by degrees to do away altogether with the night rate.

THE TELEPHONE IN THE FRENCH SENATE.—An interesting telephonic experiment has recently been made in the Senate House at Paris. Two telephones were placed on the right and left hand side of the tribune, from which members speak, and transmitted the speeches to the office of the President, in the Petit Luxembourg, with which they were in connection. There they were received by the stenograph. It is stated that they were received as clearly and distinctly as they were delivered in the tribune.

ELECTRIC LIGHT FOR THEATRES.—We announced a short time since that the Royal Theatre de la Monnaie at Brussels was to be lighted by electric light. *L'Industrie Belge* says that in all probability the lighting arrangements will be complete about the beginning of March, and that this system will prevail until the end of the theatrical season. Incandescent lamps will be used. If the results are satisfactory, the electric light will finally take the place of gas in this theatre. The Compagnie Belge et Hollandaise d'Electricité have the work in hand.

RIPON (YORKS) AND THE ELECTRIC LIGHT.—At a recent meeting of the Ripon Corporation Gas Works Committee, a report was considered from the borough surveyor (Mr. S. Harrison) relative to the purchase of the Low Mills for the purpose of generating electricity by water-power. In the course of the discussion it was stated that the city had invested £13,225 in the present gas works. Taking this into consideration, and also having regard to the apparent want of water-power at the Low Mills, the committee decided not to entertain the question.

THE MICROPHONE AND SONOROUS VIBRATIONS. — M. Serro-Carpi, in a recent note to the French Academy of Sciences, describes a method of utilising the microphone to determine the nodes and ventral segments in vibrating columns of air. He lowers a small microphone down a sonorous pipe, and by means of a telephone connected to the microphone is able to determine the difference between the sounds when a ventral segment or a node of the vibrating column of air is traversed. The presence of a node is indicated by a rolling sound.

ELECTRICITY IN FLOUR MILLS.—In a recent article on the flour mills of Minneapolis, U.S.A., *The Times* says, speaking of Mr. C. A. Pillsburg's Mill, lately built on the St. Anthony side of the river:—"Two Brush lamps are used on every floor, enclosed in air tight glass globes, each light costing, it is said, one halfpenny per hour. Electric bells are on every floor, so that any foreman, or miller, can be readily summoned. Similar bells give intimation of any choking or irregular working of the machinery. By telephone, communication can be made with Minneapolis or St. Paul."

THE ELECTRIC LIGHT IN FORFAR (SCOTLAND).—Electric lights have been fitted up in the Canmore Linen Works of Messrs. Wm. Laird and Co., at Forfar, within the last few days, by the Northern Electric Lighting Company, of Dundee. Five arc lamps have been placed in the finished and packing, and one in the lapping rooms of the factory. A lamp is also placed over the gateway. Should these lights act well the whole factory will be fitted with them. Messrs. Laird, it may be added, are said to be consumers of one-sixteenth of the whole gas consumed in Forfar. The lights were erected by Mr. G. Lowden, manager of the Northern Electric Light Company.

THE DOMESTIC ELECTRIC LIGHTING COMPANY.— Last week we noticed the formation of this Company. Its objects are to erect electric lights in private houses, and to supply motive power for domestic and practical purposes. When-

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ever sufficient subscribers are found to guarantee £600 a year, a lighting station will be set up. The price will be charged at the same rate as gas. Therefore any ten or twenty persons who are neighbours, whose bills for gas, or oil, or candles amount in all to £600 a year, can have electric light substituted with a much greater illumination. The old gasaliers or brackets can be used. The Company, whilst not binding themselves to any particular system, will adopt that of Mr. Edison as a rule. The offices of the Company are at 6, Lombard-street, E.C.

THE LATEST ABOUT THE TELEPHONE.—The use of the telephone for medical purposes is found to be a great convenience occasionally. A physician of North Adams, according to an American paper, was the other day called by telephone at about one o'clock in the morning from Briggsville, which is 10 miles away, to attend a child suffering from croup. The night was dark and stormy, and the doctor found nothing pleasant in the contemplation of the journey, which he thought might affect his own respiratory organs. He therefore answered back to the house at Briggsville in which the little sufferer lay, with a request that its parents would bring it to the telephone transmitter. This was done without delay. The child coughed its croupy cough, and the doctor listened intently to every sound which came from his youthful patient. He then prescribed the proper remedy, which was prepared and administered by one of the members of the family. The relief was immediate, and the child in a few minutes, without any huskiness in its voice, expressed its gratitude to the doctor by telephonic agency.—*St. James's Gazette.*

"THE JOURNAL OF THE SOCIETY OF TELEGRAPH ENGINEERS."—This Society takes for its pattern the Institution of Civil Engineers, but we think neither the Institution of Civil Engineers, nor the best of our English scientific societies, such as the Royal, the Chemical, &c., would allow their *Proceedings* to be a medium for trade advertisements. Surely the Society was instituted for the spreading of scientific information, and not to dabble in advertisements. There are societies and societies, and we think it undignified of a society occupying the position this one does to follow such practice. We have another fault to find with this number of the *Journal*, and it is to give an absolute and emphatic denial to the note on p. 467, which states that "the accounts of this machine (the Hefner-Alteneck) that have already appeared in English periodicals have been more or less inaccurate." We described and illustrated this machine on June 11, 1881, and we find the abstract in the society's *Journal*, when comparison has been made (our description being much fuller), agrees almost word for word with our own. The great ability with which the society's *Journal* is conducted renders it the more necessary to protest against this slur cast upon English scientific journalism and to let it be understood that we do not think the *Journal* of the society so transcendentally wise and correct that we bow our heads in silence under the rebuke of an infallible authority.

DUNDEE AND DISTRICT TELEPHONE COMPANY.—At the annual general meeting of this company, held last week, the directors' annual report for 1881 was submitted. According to this the company was progressing satisfactorily. It had been in operation for sixteen months, and there were then 150 renters using 200 wires. The income arising from the present number of renters was considerable; but the directors looked forward to a steady increase in the number as the advantage of telephonic communication became more widely known, and as the facilities arising from a large and increasing membership were experienced. The company had already secured a wide and influential connection, and it was not likely to lose the confidence thus reposed in it so long as it continued to discharge its duty with efficiency and at the present moderate rates. The profits were £853 1s. 6d.; but these represented not only a year's profits, but the whole profits from the commencement of the company's operations. In these circumstances the directors recommended the shareholders to declare a dividend of 20s. per share—10s. thereof to be paid in cash, and the remaining 10s. to be applied *pro tanto* in payment of the uncalled up capital represented by the shares already issued. The report was adopted, and new directors elected as follow:—Messrs. C. C. Maxwell, P. Matthew, and J. W. Shepherd. The other members of the Board are Provost Moncur and Mr. James Luke, jun. Mr. Simpson was re-elected general manager.

EARTH CURRENTS.—Mr. Preece's letter to *Nature*, which we alluded to in a note last week, has called forth a reply from Mr. William Ellis, of the Royal Observatory, Greenwich, who writes, by direction of the Astronomer Royal, as follows:—"Our magnetic and earth current registers both show throughout the night of Jan. 19 more or less of unusual disturbance—never, however, very considerable. The greatest deviation occurred in a sudden wave at 10h. 15m. From 10h. 50m. until midnight there was general quiet, and the disturbance afterwards was not great." Mr. S. J. Perry, of Stonyhurst Observatory, Whalley, writes that the magnetic storm "commenced shortly after 4 p.m." Mr. G. M. Whipple, of Kew Observatory, says that "a small magnetic disturbance lasted over an interval considerably greater than the earth currents observed by Mr. Preece." He fixes the commencement of the storm at 4:35 p.m. Greenwich mean time. He says:—"As is usual in such cases, the abrupt disturbance, or as it is called from the aspect of the curves, the peak, under notice was repeated or echoed on several subsequent days. On the 20th, about half-an-hour after midnight, very faintly; on the 21st it was stronger, and occurred between 9:20 and 9:50 p.m. On the 22nd, between 7:50 and 9:40 p.m., its extent then being 10′, and finally on the 23rd from 9 to 10:10 p.m., showing then about the same amount. The daily weather charts for the 20th report bright aurora seen on the 19th in Scotland and Norway."

INSTITUTION OF CIVIL ENGINEERS.—The paper read at the meeting of the Institution last Tuesday is very interesting from an electrical point of view, dealing, as it does, with one of the most troublesome points in connection with electric lighting, viz., Photometry. As is well known, great differences of opinion exist upon this question, and the recent experiments of Professors Ayrton and Perry seem to show that photometric methods requiring long distances, such, for example, as would be required with arc lights, give fallacious results, owing to the little-understood action of particles of matter in the atmosphere. Dr. Paget Higgs, the author of the paper referred to, suggests a way out of the photometric difficulties. He would measure the candle-power of a lamp by the heat radiated. Becquerel, Dulong, Petit, and others agree that the illuminating power is proportional to the heat radiated, but other investigators as emphatically deny this. Dr. Higgs comes to the conclusion that the light in an electric system varies as the fourth power of the current whose resistance or potential is constant, or as the second power of the work in the circuit. The law of the heating power of an electric current, first verified by Joule, is well known to vary directly as the resistance, and as the square of the current, or $J H = C^2 R$. The measurements required to find a value for C and R are comparatively simple, and if

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further discussion should show that the reasoning of Dr. Higgs is correct, a means will have been found to overcome the photometric difficulty.

THE ELECTRIC AND THERMIC CONDUCTIVITY OF METALS.—Following on the experiments of Wiedemann, Franz, Neumann, and Lenz, who have shown that the electric and calorific conductivities of metals are proportional, Weber, in the *Archives de Genève*, Vol. IV., has determined the relation between them for certain metals as follow:—

Metals.	Relation.	Specific heat of the unit of volume.
Copper	·2007 . 10^4	·827
Silver	·1664 „	·578
Cadmium	·1515 „	·475
Zinc.....	·1753 „	·662
Brass	·1968 „	·791
Tin	·1398 „	·380

It will be seen that the relation varies from metal to metal. The examination of the values of this relation, compared with the specific heats given in the second column, shows that it is closely connected with the specific heat c of the unit of volume. If we call R the relation between the calorific and electric conductivities, and, putting down

$$R = a + b c,$$

if we determine a and b by observations made on metals which are at the extremes of the list, viz., copper and tin, we find

$$a = ·0880 \,.\, 10^4$$
$$b = ·1365 \;\;„$$

The other metals give:—

	R	
	Calculated.	Observed.
Brass	·1960 . 10^4	..... ·1968 . 10^4
Zinc	·1784 „	..... ·1753 „
Silver	·1664 „	..... ·1663 „
Cadmium	·1528 „	..... ·1515 „

Other metals of inferior conductivity to which M. Weber applied these results by a somewhat different method gave, as also did mercury, the same empirical relation.

UNDERGROUND WIRES IN AMERICA.—The wires of the National Underground Electric Company, Philadelphia, from the public buildings to the Delaware River, were tested on the 3rd January, and the successful character of the test, it is believed, will induce the city council to adopt the underground wire for lighting the city in preference to the present system, which will, undoubtedly, be discarded. The alarm in that city over a fire produced by electric wires will, probably, result in a renewed effort to bring the millions of yards of telegraphic, telephonic, and electrical wires now there under ground. Boston, also, has authorised the construction of continuous lines of pipes by private enterprise in a large number of streets, on condition that all telegraph and telephone companies be allowed to hire reasonable space in the pipes at a rental not exceeding the cost of maintaining the wires overhead. In New York one underground wire enterprise has been vetoed by the Mayor, partly for the reason that the streets indicated were already too full of sewer, water, and gas pipes to give room. It is evident that the time has come for studying and utilising the whole subsoil of New York. On some definite plan, the entire underground street and park accommodations of the city should be so catacombed that, whether for pipes, sunken railroads, or other purposes, they can be had on proper and impartial terms, and in such a way as to relieve the streets of the masts, cross pieces, wires, railways, and other obstructions which now help to take away from many narrow streets their sunlight and air, or clog the free passage of the people and disfigure the thoroughfare.—*Engineering News* (New York).

OPPOSITION TO ELECTRIC LIGHTING BILLS.—According to the *Journal of Gas Lighting*, a decision was given last Thursday by Mr. Robinson, one of the Examiners of Petitions for Private Bills as to the allegation by the Alliance and Dublin Consumers' Gas Company that the Standing Orders had not been complied with in the cases of the Bills of the British Electric Light Company, the Anglo-American Brush Electric Light Corporation, and the Electric Light and Power Generator Company. Mr. Robinson said he had to decide two questions—first, that which he might call the main question—viz., that relating to the powers proposed to be conferred upon local authorities by clause 6 of the Bill; and, secondly, that which he might designate as merely the incidental powers conferred upon local authorities by clause 12, of applying their funds towards carrying into effect the powers conferred by clause 6. The words in clause 6 conferring these powers upon local authorities were as follow: "For the purpose of carrying into effect any agreement or contract with the company for all or any of the powers by this Act conferred on the company, but subject to the restrictions and the provisions of this Act." The powers of the Bill were practically contained in clause 3. The existing right of the company to generate—or, so to speak, to manufacture—electricity by means of a machine, and to supply the same to the public, so long as they did not interefere with the public or private rights, was unquestioned. In this respect they stood upon the common ground of any vendor of any manufactured article, and he was therefore justified in construing so much of clause 3 as preceded the 4th subsection as simply interpreting or qualifying in its character. The 4th sub-section contained the further powers sought by the company, which would enable them to interfere with public or private rights. They could break up streets and roads for the purpose of laying down tubes and other apparatus connected with the supply of electricity, and also to erect and maintain, for the purposes of the electric light, posts in streets or public roadways. These were practically the only powers conferred upon the company, and therefore they were the only powers conferred upon the local authorities. He held that the words of the notice were quite sufficient to cover these powers, which were the object of the Bill. He could not therefore sustain the allegation that it was illegal. With regard to the question relating to the application by the local authorities of funds towards carrying into effect the powers conferred upon them by the Bill, obviously if the local authorities were to exercise these powers they must have the money wherewith to do so; and it appeared to him that any person possessed of common sense would, on the reading of the notice, infer that the local authorities were to do those acts at their own expense, and out of the moneys to be raised for the purpose. Or, if he had any doubt about the matter, he would refer to the Bill and find out the precise means by which the powers were to be carried into effect. He regarded the powers in clause 12 as incidental to those conferred in clause 6, and should not therefore sustain the allegations made in reference to it by the opponents of the Bill. The general question as to the necessity of notice of power to supply electricity, and to do such acts as were authorised by clause 3 of the Bill by local authorities, had not been raised before him, and it was thus unnecessary for him to pronounce any opinion upon it. He should merely decide that the Standing Orders had been complied with.

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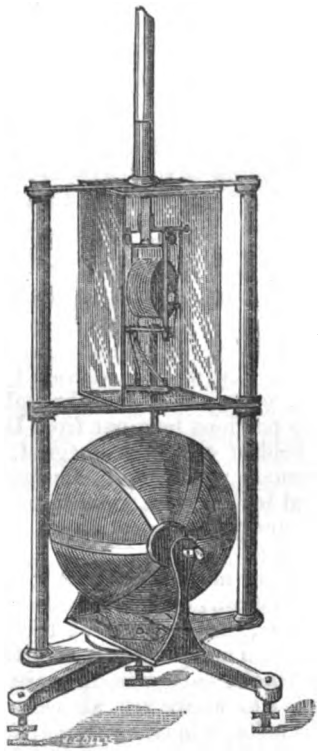
FROHLICH'S SPHERICAL AND ASTATIC ELECTRO-DYNAMOMETER.

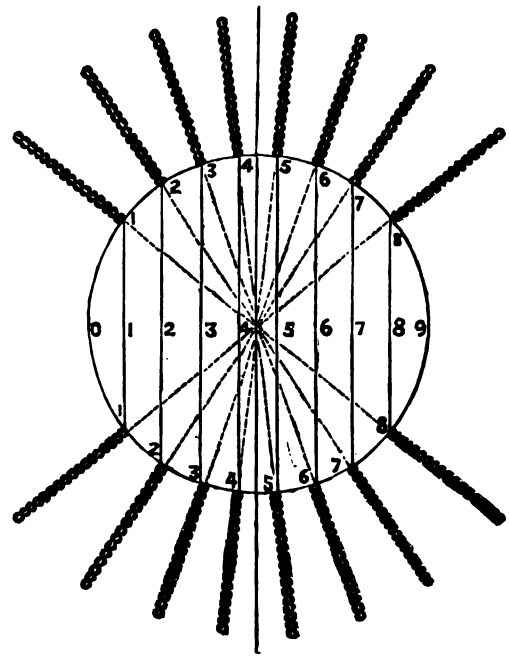
By the method of construction adopted Dr. Fröhlich claims to obtain a perfect astatic system. The effects of terrestrial magnetism being thus counteracted, the action of the couple is rigorously and directly proportional to the cosine of the angle of deflection. The two hemispheres each consist of a system of 20 spirals, each spiral having fifty



turns of wire, forming a hollow sphere (Fig. 2), which, under electro-magnetic action, forms an uniform magnetic field. The external action is the same as that of an infinitely small magnet of finite moment. When a current, i, traverses the instrument, causing a deflection, ψ, of the apparatus with bifilar suspension, we obtain the value of the current to a precision of 1-10,000th, thus:—

$$i^2 = \frac{\frac{1}{4}\frac{\alpha\beta}{\lambda} m g \sin\psi + \tau\psi}{\left[\mathrm{F\,M'} + \mathrm{M_s\,M''}\frac{1}{r^3} f(\mathrm{R_1''}, \mathrm{R_2''}; b, r)\right]\cos\psi}.$$

In this equation, α and β represent the distance between the two ends, upper and lower, of the suspension wires; λ, the length of one wire; m, the mass of the suspended apparatus; g, the acceleration of the terrestrial attraction; τ, the torsion constant of the suspension wire; i F, the electro-dynamic force of the sphere exerted in the hollow interior; i $\mathrm{M^s}$, the electro-magnetic moment of the sphere, exerted on external points; i M', the electro-magnetic moment of the upper coil; i M'', that of the lower coil; $\mathrm{R_1''}$, the internal radius of the upper coil; $\mathrm{R_2''}$, the external radius of the same; b, the semi thickness of the upper coil; r, the distance between the extremity of the axis of the upper coil and the centre of the sphere. Of all these quantities, i and ψ alone are variables. A complete theoretical description



of this instrument will be found in *Wiedemann's Annalen der Physik und Chemie*, Vol. VIII., 1879, p. 563.

CORRESPONDENCE.

"WHAT IS ELECTRICITY?"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the animated correspondence between Mr. James Johnstone, of Edinburgh, and Professor Sylvanus Thompson, of Bristol, in your issue of January 14th.

The solution of such a problem as the nature of the electric force, its single or double character, and its connection or otherwise with matter and energy, is doubtless of immense importance to humanity, for in some way or other electricity is associated more or less intimately with every form of matter with which we are acquainted, and any change in the condition of the matter is accompanied with a corresponding change in this all-pervading force.

Some investigations upon which I have been engaged during many years—a brief outline of some of which appeared in *The Electrician* for June 25, 1881, appear to me to throw much light upon the nature of electricity, its condition as a single *and* double force, *together with its connection with matter and energy.*

These researches in their more extended form enable us to trace its action as an agent from the most minute centres in the three kingdoms of nature which we can recognise with the microscope to the mass of the earth itself, and from thence by the telescope to system after system in the universe, in each of which the same mechanism is manifested by force acting upon the same lines.

I, therefore, venture to ask you to afford me space for some further remarks to ventilate my premisses, which, if found correct after being subjected to other minds, cannot in their application and influence be overestimated.

I do not claim that the methods I have adopted in my investigations are essentially new, but that the very minute test magnets I have employed to trace out the manifestations of this force in its form of magnetism over every portion of the surfaces of magnets—magnets under separate and combined action—have enabled me to *divest this branch of science of all theory and to reduce it to a system of applied mechanics.*

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I have already shown in the paper to which I have referred that these very minute test magnets are wonderfully faithful indicators of the direction of the force moving in artificial magnets; and it cannot be questioned that we are much more capable of ascertaining the nature of the force by careful observation of phenomena in magnets of low than great power, upon the same principle as the practical mechanic would carefully inspect every portion of some complicated mechanism prior to forming an opinion as to its powers, or the practical anatomist and physiologist requires his needle points and microscope to unravel the structures of an animal body before he can acquire any correct knowledge of its mechanism or detect that which constitutes disease.

I shall now endeavour to demonstrate

1. That all electric and magnetic phenomena are only different manifestations of that *energy which exists in matter as an element of its constitution.* This force, when accumulated on the surface of bodies, is known as static electricity, when it traverses them freely it is known as voltaic electricity, and when the matter in which it exists has a great capacity for the force, and offers considerable resistance to its passage, helical currents and other phenomena are manifested, and it is recognised as magnetism. Consequently, as a rule, static electricity is developed most readily on those forms of matter which have a *feeble conducting power*, the voltaic current is exhibited with the greatest power in those forms of matter in which *the resistance* to the transit of the force is *least*, and magnetic phenomena in those bodies which have the *largest capacity* for force and offer the *greatest resistance to its transit.*

2. That the axes of the electric and magnetic forms of force are in the same plane, and that the explanation hitherto received of the cause of the movement of the galvanometer needle is, consequently, incorrect.

3. That the magnetic force is essentially a force moving in helical lines, and, consequently, that the *closed circuits* of voltaic electricity, to which Ampère attributed magnetism, do not and cannot exist.

1st. Electric and magnetic phenomena are only different manifestations of that energy which exists in matter as an element of its constitution.

It was shown by Faraday that magnetic force pervaded all matter and space in a measure commensurate with its density.* I shall show further on the mode in which this magnetic or electric force gives *density* and *causes gravitation by binding matter down to the earth's centre* to such an extent that it is impossible to move one form of metal over another metal without originating, as Faraday stated, currents of electricity in *both*, owing to a change in the direction of the axis of force, which change is common to both.

The same principle holds good with static electricity from the same cause; and acknowledging the fact, we establish the law that *the developed phenomena must vary not only with the nature of the matter, but also with the description of motion and every other physical change to which the matter is subjected.*

This principle also accords with known and well ascertained facts, for when vitreous, resinous, or other forms of matter of feeble conducting power are rubbed with another form of matter, which differs in its nature from the matter rubbed, *the motion imparted to the molecules disturbs the balance of that force which each form of matter inherently possesses*, and the well-known phenomena of a static charge, which differs in its character with the physical conditions of the matter, appears on each body.

Neither are we at a loss to understand that these phenomena are capable of being maintained to almost an indefinite extent without any appreciable change in the matter rubbed, *for it is impossible to separate the bodies undergoing friction from their connection with the force of the earth.* The communication may be more or less perfect as the conducting media *vary* in conductivity, but the matter cannot be taken outside that magnetic field which envelopes the earth; and, consequently, as soon as force is set free by a disturbance of equilibrium, the phenomena attendant upon polarisation are manifested, motion in a given direction occurs, and the situation of the force moved is occupied by fresh force from the earth. We also perceive that in this very fact we have *another source of disturbance of power in the two forms of matter*, for if one of the bodies in the shape of the rubber be in contact with the earth, and the body rubbed is only in contact with the atmosphere, the force generated in the two must vary; for whilst the force set free in the matter in contact with the atmosphere only must rapidly accumulate, the force in the rubber, owing to its connection with the earth, must be rapidly destroyed, owing to the tendency every form of matter exerts to acquire equilibrium.

We thus see that when electricity is developed by friction the potential, or, possibly, it may be more correct to say the density of the surface force of the two bodies undergoing the process, is disturbed in each in proportion to the friction each undergoes; but whilst, in the one case, the force set free increases with the friction, in the other *equilibrium is restored almost as soon as it is disturbed*, and force in such state is *not recognised.* A satisfactory explanation appears to be thus afforded as to the cause of the force in the two bodies not being equal, although, as Faraday asserted—and in general terms it is probably strictly correct—the force developed in the two bodies is equal.

We also recognise the fact that the force developed in the *two* kinds of matter is but *one force*, and *takes its origin in a force common to both, for the motion of two dissimilar forms of matter, and especially motion in two opposite directions, has imparted two opposite directions to the force, and so originated the conception of two electricities.*

Again, recognising the principle that electricity is the force which matter inherently possesses, and that the terms positive and negative, &c., apply to differences in the direction of the force, we can readily understand why *different modes of rubbing produce different results;* and also the cause of flannel acquiring different electrical properties with such rapidity and uncertainty; for when we regard flannel from a magnetic point of view we can scarcely believe that such a substance can be precisely the same throughout; and, doubtless, were any two portions torn out from the same piece and examined in the field of an electro-magnet, molecular, if not structural differences would give dissimilar directions to each. Superadded to which we should probably have other differences from unequal absorption of moisture or other mechanical impurities.

The same principle must also hold good with a feather struck lightly against canvas, or the same feather drawn with a little pressure between the folds of the same canvas, the difference in the motion and pressure converting a larger degree of potential into kinetic energy in one case than the other.

The facts alluded to above are all clear indications that *static electricity results from two forces acting upon matter in two magnetic states in two opposite directions, and that the equilibrium of the magnetic force which they inherently possess is overcome by that motion and polarisation is imparted.*

Voltaic Electricity.

Turning now to voltaic electricity we find the same principle evolved, but in place of surface pressure the potential energy of the mass has to be considered.

In his fundamental experiment Volta took two polished plates of dissimilar metals, copper and zinc, and provided each with an insulating handle. These plates were placed in contact with the collecting plate of a condensing electroscope. The zinc plate was found to be polarised in one direction, and the copper plate in the other. In a subsequent experiment he coupled plates of dissimilar metals together by means of a wire, and then immersed them in acidulated water. A current of electricity flowed through the wire, the direction being from the copper to the zinc through the water.

In both these experiments we are dealing with *two forms of matter the magnetic and electric states of which differ.* In the first experiment they are surrounded by the atmosphere (a compound body containing oxygen, a highly magnetic form of matter) which is thrown into motion by every movement which occurs. In the second case they are immersed in a

* The electro-magnet proves that the axis of this magnetic force differs in every form of matter, and even in the same matter under different conditions and relations to contiguous matter.

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fair conducting medium, through which the magnetic influences are appreciable, and which has the power of originating motion by virtue of its component elements.

In both cases each element is playing its part in originating motion by changing polarity and disturbing balance of power; and the phenomena result from an effort of nature to restore that equilibrium which the contiguity of dissimilar bodies had temporarily destroyed.

But whilst the efforts are feeble with the dry metals and dry atmosphere, and, in fact, partake more of the character of surface charge or *static* electricity, they are much more powerful when the plates are dipped into water; partly because the water conducts the vibrations or influences of the metal plates much more readily than can be done by the dry air, and partly because the water is an electrolyte which very readily yields the force which has combined the molecules of the gases and condensed them into the liquid state.

As I desire that my meaning should be perfectly understood with regard to the condensation of the two gases by the compressing power of the two currents of magnetic or electric force, I would thus put forth the theory.

When charges of electricity are passed through the two gases, oxygen and hydrogen, mixed in proper proportions in a fitting vessel, the two dissimilar currents seize upon the particles of matter in two different magnetic states, each current, discharge, or vibration selecting by preference that form of matter which is most in accordance with its own character or *lines*. The two forces then unite, *and in the act combine the particles of matter, and compress the gases into a liquid state.* Upon such a theory we can readily understand that when dissimilar plates of metal, in the form of a voltaic couple, are immersed in water, the plates will establish currents of force, and that these currents will attract like force from the form of matter which most readily parts with it. In this case, the water and the combining force having been removed, the matter resumes the gaseous state.

But what becomes of the force set free by this means? Unquestionably it becomes inappreciable in that state of equilibrium from which it had been withdrawn, and is then again lost in the great reservoir of the earth. For the two forces, or, rather, the two directions which are imparted to one force, pass away in opposite lines and recombine as helices of force, precisely upon the same principle as I have briefly described,* and shown to be the cause of magnetic attraction.

By way of recapitulation I believe I may say that I have thus shown

1st. That the general magnetic condition of matter—in which we recognise its potential energy—under certain relations of that matter is bound to originate two currents of force moving in opposite directions.

2nd. That electricity is essentially an indestructible force, and as the force has the power of doing work it is energy.

3rd. That in static electricity the force developed by friction must be equal in the two forms of matter subjected to the process, and that force originated by motion in two directions must itself partake of the two directions.

4th. That the forces when developed cannot remain equal, owing to the difference in the media by which they are connected with the earth.

5th. That the special arrangement of matter which exists in the voltaic couple converts the potential energy of the earth into kinetic energy, and by so doing gives a *new direction* to the force, and may originate the phenomena of attraction or repulsion according to the manner in which force is applied to matter or matter to force. Therefore, although by the laws of gravitation every form of matter must attract other matter in proportion to the mass, and so to the earth, yet the exception proves the rule; and in cyclonic storms and the lower cone of the waterspout we have in nature evidences which, when taken in conjunction with the helical motion of the matter and compared with the helical motion of magnetic force, identifies the force acting in both, and proves that in gravitation, as in all other forms of force, the *resulting phenomena are modified by the direction of the force;* and inasmuch as we cannot separate matter from force, electrical attraction is a similar modification of the same law from the same cause.—Yours, &c.,

R. Shettle, M.D.

London-street, Reading, January 31st, 1882.

* *Vide The Electrician*, June 25, 1881, p. 93.

STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Your issue of Jan. 7 informs me that a new storage battery, devised by Mr. Henry Sutton of Ballarat, Australia, has been communicated to the Royal Society. One of the chief, if not the chief, features of novelty was described as a mercurialised lead plate, with which Mr. Sutton obtained excellent results.

Permit me to say that I had as early as Nov., 1880, a secondary or storage battery in use, in which the lead plate used as positive electrode was mercurialised, and that this device has been patented by me in this and other countries, as well as a further device for increasing the quantity of material to be acted upon, all of which improvements I describe in a paper to be presently sent to the Institution of Civil Engineers and to the columns of your valuable journal. I could wish that the *Proceedings* of the Royal Society were more publicly accessible, and must ask you to allow me to compliment your journal as being my chief source of information on matters electrical here.

I would point out that the battery described by Mr. Sutton is limited in its capacity by the amount of copper the solution can contain—a very limited range.—Yours, &c.,

New York, Jan. 21, 1882. Paget Higgs.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: At the present time, when so many are interested in electric storage and electric lighting, I imagine that any details concerning the construction and working of secondary batteries will be welcome to your readers. I had the pleasure of presiding at a lecture delivered here last Tuesday by Mr. Thomas Parker (Coalbrookdale) upon the subject of "Electricity and its Practical Applications." Towards the close of the lecture Mr. Parker exhibited Swan's and Edison's incandescent lamps, which were kept brilliantly illuminated for *fifteen minutes* by the current from two storage batteries, constructed upon the principle of M. Planté's invention. Each battery was a wooden box 18in. long, divided into 20 cells by glass plates, each cell containing two lead plates, a quarter of an inch apart, and measuring 6in. by 5½in. The apparatus was hastily put together for the lecture, and, considering it was only *eight days* in "forming," I think the lecturer is to be congratulated on its success. The lamps worked up to much more than their nominal candle-power, the Swan lamp of "20 candle-power" (!) lighting the room nearly as well as the 18 gas jets usually in action.—Yours, &c., T. Law Webb, M.R.C.S.

Coalbrookdale, Feb. 8, 1882.

A SUGGESTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Thinking of electricity—and there are few subjects more interesting that the mind can dwell upon—it has occurred to me that messages might be transmitted, controlled, but the necessary current not produced by man.

I assume that on all telegraph lines put to earth, what are known as earth currents are always traversing in one direction or the other.

Insert a sufficiently sensitive receiving instrument at each end. For a sending instrument insert at each end a variable resistance, which, accordingly as it is varied by the operator, will produce a signal at the receiving end. Of course it is a matter of difficulty that a telegraph line is a fanciful battery, not even always in one mind as to which end shall be + and which −.

If this idea be at all new, and have a grain of sense in it, I shall be delighted that through your good medium some one may make use of it.—Yours, &c.,

King's College Hospital. Edward Almack, A.S.T.E.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

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NOTICE.—OUR SUPPLEMENT.

The supplement containing "Hints to Electric Light Engineers," published with our issue of the 7th January, can now be had at the office in pamphlet form, price one penny. In reply to several of our friends we may say our next Supplement is in active preparation, and we hope to be able to issue it shortly.

SCIENCE AND THE DAILY PRESS.

We have been informed that it is a rule with some of our daily contemporaries that, when they are desirous of instructing the public as to the newest applications of practical science, a trustworthy, intelligent reporter should be selected with this primary qualification—*that he should have no previous knowledge of the subject.* The object is to provide against the influence of preconceived opinions. We cannot say that this is really a generally adopted principle, but the very curious statements of fact (?), and the very confident opinions generally given us by the ordinary newspapers as to matters of technical and practical science, lend some degree of probability to the suggestion. Recently several of the papers have interested themselves in what is claimed to be a new and important invention for sub-dividing the electric light. Electricians, of course, know that it is not a process for sub-dividing the light at all, but for dividing the electric current, which is an altogether different matter, and that, furthermore, it is neither new nor important, nor, in fact, in any sense an invention at all. We may take the account given in the *Standard* of the 2nd instant as typical. It is just such an account as might be given by just such a reporter as we have referred to; the subject has evidently been fully and fairly examined, and correctly and intelligently described. But the writer evidently has not the faintest consciousness that all this which he so elaborately describes is among the veriest common places of applied electricity. Let us see: "Considerable interest is being excited at the present time by the system of sub-dividing the electric light invented by Mr. John Banting Rogers, and there is every probability that this mode of illumination will soon be brought prominently before the public. Mr. Rogers's speciality consists in the ability to divide and sub-divide the electric current to any degree of minuteness, and in such a manner that, while there is a general distribution of the electric force, each lamp has a circuit to itself. The arrangement is highly ingenious, and promises many advantages. According to the principles generally adopted by electricians, the plan invented by Mr. Rogers is open to some objections, especially as being calculated to diminish the total amount of light. Yet, so far as the system has been tried, the results have appeared satisfactory." We wonder if any electrician is to be found who regards the plan with any interest, who would see any advantages in it, or who would object to it as likely to diminish the light. We need not quote the description at length. The invention consists in the use of metallic spheres, to which the current is led by one wire, and which carry connections from which circuits may be closed either to lights or to other sub-dividing spheres. But there is one part of the description so funny that we cannot refuse our readers the chance of a smile more or less broad. "There is no particular virtue in the spherical form thus adopted. Instead of spheres there might be plates or rings, though the object of the inventor is to obtain as large a surface as may be convenient, his idea being that when a wire is brought into circuit with these spheres it will transmit only a small portion of the current to which the spheres are subjected, seeing that it touches so small a portion of the entire surface." This reminds us of the warning given by Lord Mansfield to a newly appointed judge. He said: "Deliver your judgments decisively, but never give your reasons; your decisions may probably be right, but your reasons will probably be wrong." Of course, either a sphere, or plate, or ring, would be equally available, so also would a single wire end soldered to or twisted up with as many others as may be desired, because the whole invention is describable in three words—it is a *compound binding screw.* It differs in no way from the appliances attached to many apparatus where a bar of metal receives a current, and by a plug connects with several smaller blocks, each connected to a special instrument. It is, in fact, nothing but an ordinary connection from which several derived circuits start. Plenty of inventors have wasted their energies in like manner by mistaking the sub-division of currents, as to which there is no kind of difficulty, for the sub-division of light, which in the arc system does involve difficulties and loss.

Unfortunately, the "Promoter" is apt to take a "considerable interest" in such matters, and when he presents them to the confiding British public, backed by a few columns of "what the Press says," the British public, always looking for some new thing, is apt to follow the course of the old lady who was quite sure a thing must be true because she had seen it in "print." Therefore, the papers take on themselves a serious moral responsibility when they venture beyond their natural sphere of politics, general literature, social questions, or even the more recondite matter of theology. These are subjects as to which any clear-headed, thoughtful man can form an opinion of some value. But technical matters need a special knowledge, and as the general public cannot avail themselves of the guidance of technical papers, newspapers really ought not to deal with them by means of ordinary reporters, but should employ specially qualified guides for such special subjects, or leave them alone altogether. It is better to do nothing than to do mischief.

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THE CRYSTAL PALACE EXHIBITION.

Although we shall continue our notice of the miscellaneous exhibits this week, the various systems of electric lighting will have our attention in the next issue. A great deal of work has been got through lately in the various installations, but the Electric Light and Power Generator Company had the proud position of being first in a complete state, and have for some time past regularly had their Weston arc lamps and Maxim incandescent lamps burning. The last in the field are Mr. Swan and Messrs. Siemens. Probably before these lines are read the electric light installations will be practically complete.

Apparatus for Schools, &c.

Messrs. Orme and Co. show a selection of apparatus designed for use in schools for teaching purposes. The selection of apparatus for school work is not such an easy matter as it may seem, and we have no doubt many masters

Fig. 1.

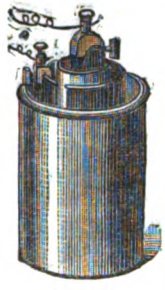

Fig. 4.

Fig. 5.

Fig. 6.

will avail themselves of the opportunity now offered of comparing the work of the several manufacturers. Already the progress of the applications of electrical science is making its mark upon our educational system. The late School of Telegraphy is now the College of Electrical Engineering, the City Guilds Professors seem to have a preference for electrical subjects, and those parents who are looking to the future are making enquiries as to where a theoretical and

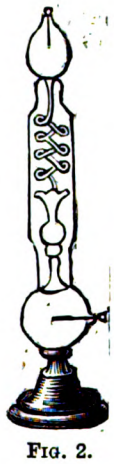

Fig. 2.

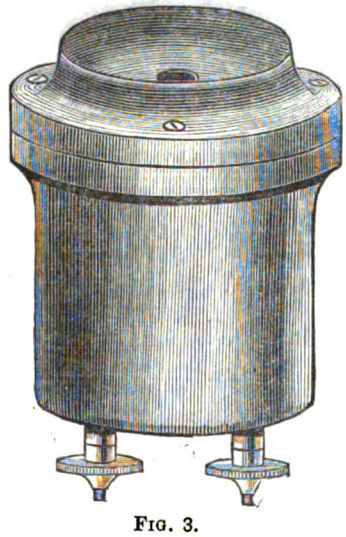

Fig. 3.

practical knowledge can be obtained. The instruments of Messrs. Orme and Co. are well known. Among other things a large air pump is exhibited, the obtaining of a perfect vacuum being a principal object in the manufacture of incandescent lamps. Of course, in the actual work, other, better, and cheaper means of exhaustion are employed. A series of vacuum tubes, examples of which are shown in Figs. 1 and 2, which are used to show the effects of the electric current in partial vacuum, and in various gases. Fig. 3 is an illustration of Hickley's telephone, a number of which are connected to the offices of various exhibitors, and thus may be seen in action. We are told that a large number of these telephones are in use, and, in conjunction with carbon transmitters, are found to answer very well. They are simple, and, it is said, improve with use. A number of batteries of the types Daniell, Leclanché, bichromate, &c., are exhibited, forms of some of which are illustrated in

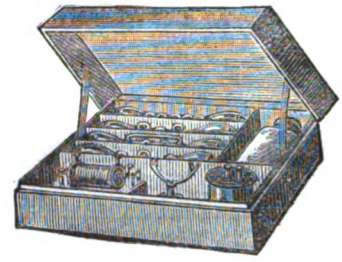

Fig. 7.

Figs. 4 to 8. Coils of various designs, such as in Figs. 9 and 10, are exhibited, while Fig. 11 illustrates an ordinary plate electrical machine, so generally used to show various phenomena of statical electricity. We have indicated but a few of

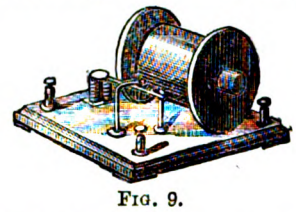

Fig. 9.

the more important exhibits, as our readers would be but little interested in the thousand and one designs for electric bell stands or pushes. It may be remarked, however, that various appliances to ensure protection from burglars, &c.,

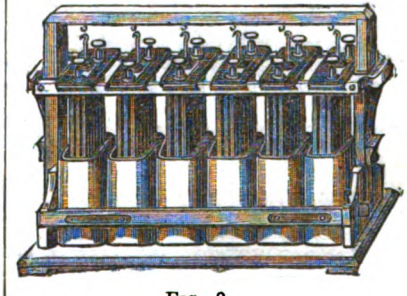

Fig. 8.

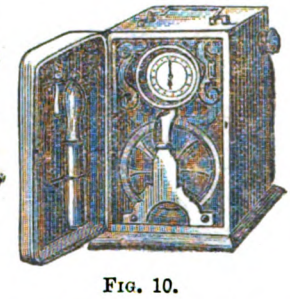

Fig. 10.

are shown in action. The opening of a door or window is made to ring an alarm bell over which the opener has no control. In the midst of the interest in the electric light such exhibits as these may perhaps be passed by as uninteresting, but certainly they deserve some attention as being the instruments by means of which the first notions of electrical science are instilled into the minds of those who are to carry on the work but now commenced.

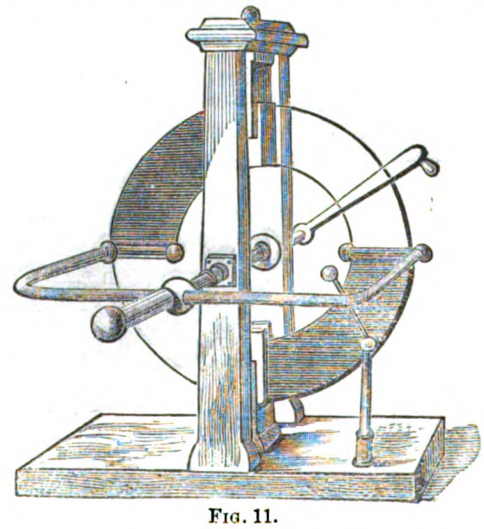

Fig. 11.

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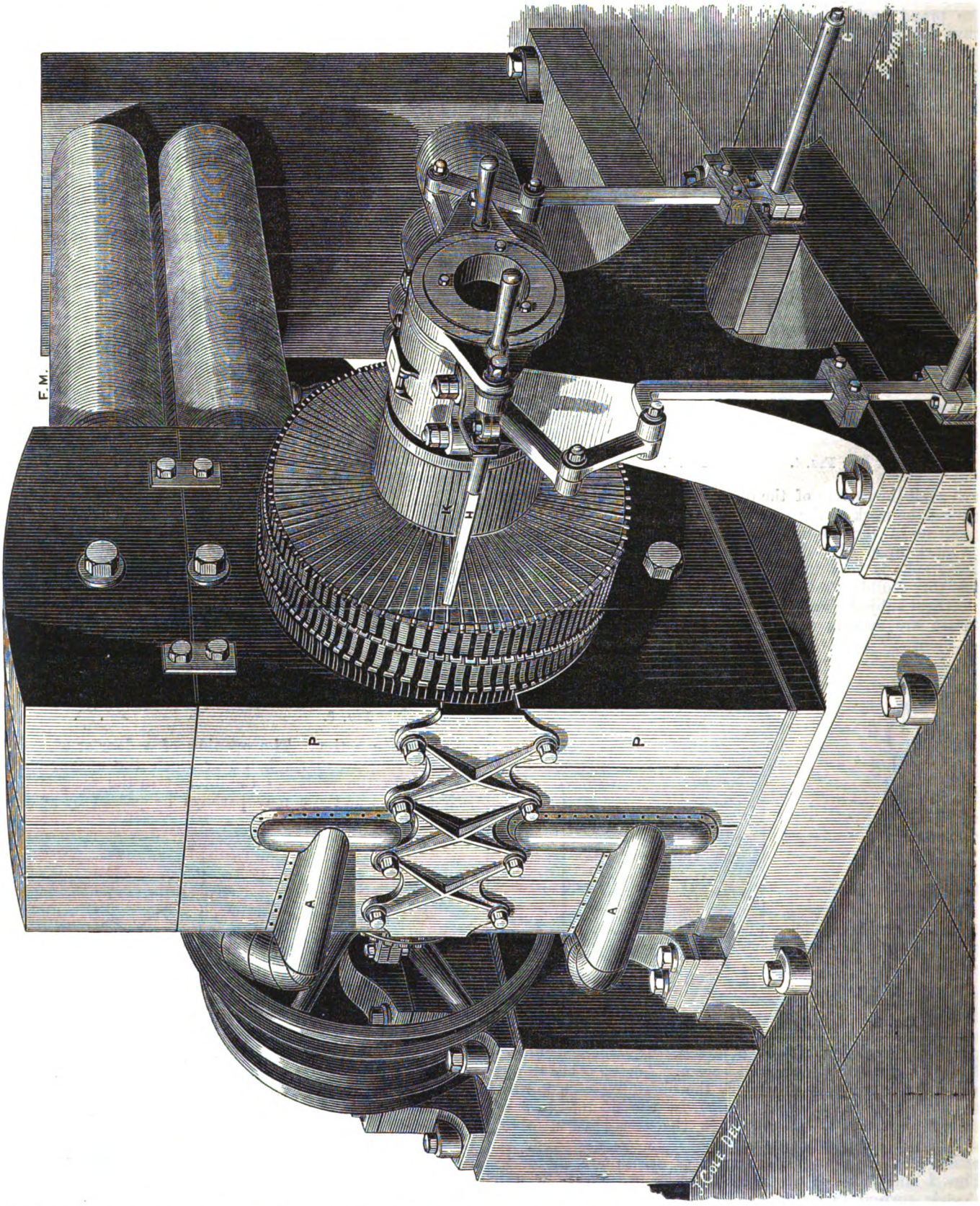
THE INSTALLATION OF THE EDISON LIGHT.

Last week we showed the arrangement of a dynamo designed for the work in New York. We now give a perspective view of the machine as erected at Holborn. The letters



F M indicate the field magnets, P the poles, A A the pipes in the air-circulating apparatus, H the holder for one of the brushes, K the commutator, C the main wires. It will be seen from the diagram that the New York machines are designed with three electro magnets, but the Holborn machine is designed with four electro magnets, with the coils on the upper side duplicated, and an additional mass of metal added to the pole-pieces. These additions were made upon the designs of the smaller machines, and were not decided upon till the machine was partly built, hence there is a lack of symmetry in the dynamo, which in future machines

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will probably be obviated by similarly duplicating the lower coils. The addition of an extra set of magnets also diminished the area of the bearings, but these defects, being admitted, will easily be overcome in the next machines. The dynamo machine and Porter-Allen engine are built on a cast iron base plate, the whole weighing about 22 tons. The field magnets are of cast iron, and the resistance varies between 1·95 and 2·13 ohms each. The magnets are connected in series of six, the resistances respectively of the series being 12·23 and 12·22 ohms. The two series are connected in multiple arc, the aggregate resistance being thus reduced to 6·11 ohms. This value is easily obtained from the formula for such multiple arc resistance, viz., $\frac{x\,y}{x+y}$, x in this case being equal to 12·23, and y equal to 12·22, the formula becoming $\frac{12{\cdot}23 \times 12{\cdot}22}{12{\cdot}23 + 12{\cdot}22} = 6{\cdot}11$.

The magnets are wound with No. 10 wire, Brown and Sharpe's gauge. The enormous pole pieces are of cast iron, and Mr. Edison strongly maintains the necessity for using such pole pieces, as conducing to economy.

The armature consists in the first place of a steel shaft 6in. in diameter, over which is fitted a wooden cylinder 12·5in. external diameter. On the central section of this cylinder a large number of thin discs of sheet iron are slipped, the discs being insulated from each other by sheets of tissue paper. Among these discs, however, are eight of $\frac{1}{4}$in. thickness, to

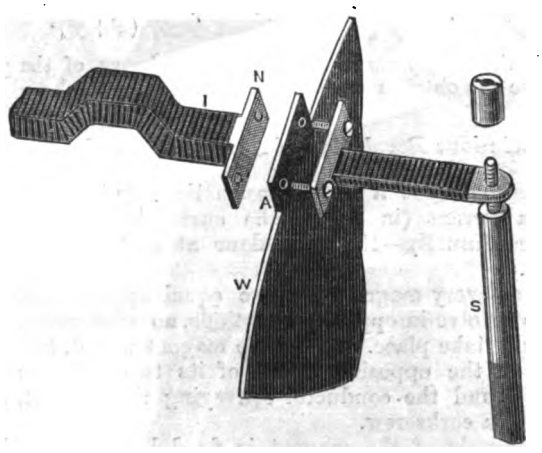

Fig. 1.

give the necessary strength, and the whole is bolted together by eight bolts, each 1in. diameter, and 44 9-16in. long. These iron discs form the core of the armature. At the end sections of the armature are a series of copper discs somewhat larger in diameter than the iron discs. We illustrated one of the armatures of the small dynamos in our issue of November 26th, 1881. In the Holborn machine there are 53 such discs, each 26$\frac{3}{8}$in. diameter, ·102in. thick, B and S gauge, with alternate discs of prepared paper, ·015in. thick for insulation. Each disc has two lugs on its circumference, to which the armature rods are connected. Fig. 1 shows one of these lugs with the method of connection. W is a copper disc, A the lug, I the armature rod, S the commutator connection. Fig. 2 shows a larger portion of the armature with the various connections as made. The copper rods I, used by Mr. Edison to take the place of the usual windings of wire, are 106 in number, ·634in. on the face, narrowing slightly to the inside face, the edges being rounded; they are $\frac{1}{2}$in. thick, and average in length 52in. These rods are wrapped by machinery with prepared paper, the layers of paper being each coated with a special insulating material. The rods are separated from each other at every foot of their length by pieces of vulcanite fibre encased in mica, and also by an air space of ·038in. Every alternate rod is connected through a radial copper rod with the commutator. The blocks of the commutator are fifty-three in number, and taper in a similar manner to the armature bars, are bevelled at the ends, and separated by strips of mica. The diameter of the commutator K is 12$\frac{3}{4}$in. At the back of the radial bars, and acting as a facing to the copper discs, is a mahogany disc $\frac{1}{2}$in. thick. The complete armature is wound with steel wire, with double mica insulation underneath; this wire is intended to counteract any centrifugal action. The bar upon which the brush holders are fastened is shown at H; the brushes are connected with the main conductors C through levers, as shown, and can be changed as regards position on the commutator as required. The drawing shows clearly how this is done. So careful has the inventor been to consider everything connected with the machine that, to prevent oxidation, the threads of the radial bars, the lugs on the armature, discs, screws, and other contacts are lightly plated with gold. This perfection of contacts, together with the large sectional area of the armature rods, ensures low resistance. In the machine at Holborn the resistance is as low as ·0049 ohm, whilst we are told that in another machine, now *en route* for London, the resistance is but ·0032 of an ohm.

The engine is of 40 h.-p. nominal, working up to about 125 h.-p. indicated. The cylinders are 11in. diameter, with 16in. stroke, the cut off taking place at about half stroke. The engine is connected direct to the shaft of the armature, which revolves at the rate of 350 revolutions per minute.

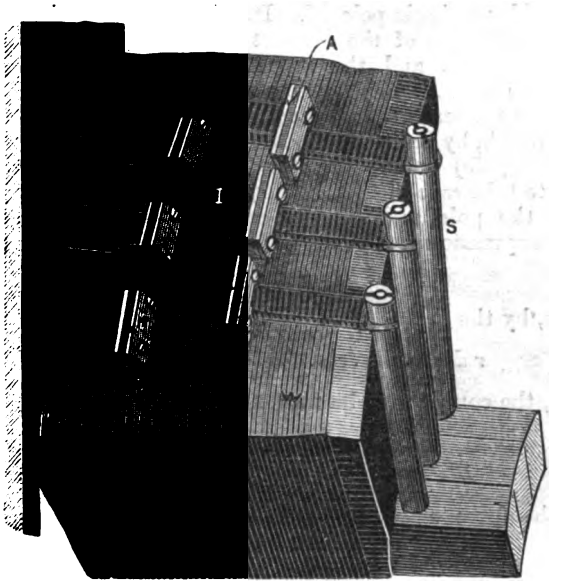

Fig. 2.

This machine is intended to supply the current for 1,000 Edison lamps of 16 candle-power each, and is the largest machine hitherto erected. The new machine has been tried with 1,360 lamps, running for 15 hours per day for several consecutive days. Taking the figures as above given, the Holborn machine, with an expenditure of 125 h.-p., gives 16,000 candles, or 128 candles per horse-power.

Crystal Palace Electrical Exhibition.—The total number of exhibitors included in the published catalogue of this exhibition is 262. The following are the numbers of exhibitors in some of the sections, viz.:—Batteries, &c., 22; magneto-electric and dynamo-electric machines, 25; cables, wires, conductors, &c., 43; apparatus for measuring electricity, 17; telegraphs, signals, &c., 51; telephones, microphones, and photophones, 26; electric lighting, 36; electro-medical apparatus, 17; electro-chemistry, 9; magnets, compasses, horology, instruments of precision, &c., 24; generators, steam, gas, and hydraulic engines, 22. There are 91 foreign exhibitors, although, as many of them exhibit in more than one section, this number is subject to a slight reduction.

Electric Light for Ontario (Canada).—This town is apparently going in for electric lighting on the tower system. Recent news says that the construction of an electric light tower, 150ft high, has been commenced.

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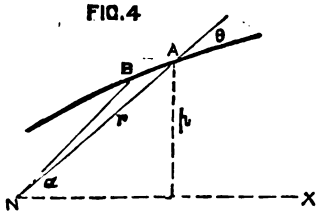
ON THE THEORY OF DYNAMO AND MAGNETO MACHINES.

VIII.

Action between an Elemental Arc of Current and a Magnetic Pole.

At the end of last week's article we obtained an expression for the force exerted by a pole on any portion A B of a circuit conveying a current; it is interesting to note what this expression $m\gamma$ (cos. β − cos. α) becomes when the portion A B is taken infinitely short. We shall thus find, in fact, the force exerted by a pole on an *element* of current, or reciprocally the action of the current element on a pole.

FIG. 4



Consider a single pole, N. Its distance from the element call r, the length of the element ds, the angle which it makes with r call θ, and the angle A N X call α as before; the angle B N X, or β, being now simply $\alpha + d\alpha$. Moreover, the perpendicular distance of the element from the axis N X (which, by the way, is quite arbitrary as long as we have only one pole) we may call, for the instant, p. Then, leaving signs to take care of themselves, the moment of the couple which the pole and current exert on each other is by the above expression

$$m\gamma d \cos.\alpha = m\gamma \sin.\alpha\, d\alpha.$$

But, by the geometry of Fig. 4,

$$r\,d\alpha = ds \,.\, \sin.\theta, \qquad \text{and } p = r \sin.\alpha;$$

hence, the couple may be written

$$\frac{p\,m\gamma \sin.\theta\, ds}{r^2},$$

and the force acting both on the pole and on the element, since it is the couple divided by p, is

$$\frac{m \sin.\theta}{r^2}\gamma\, ds.$$

Now, this is Ampère's well-known formula for the action between a pole and an element of a current. The force varies inversely with the square of the distance between the pole and the element, it acts at right angles to the line joining them, it is proportional both to the strength of the current and the strength of the pole, and it is also proportional to the length of the element projected perpendicularly to r.

By a process of summation the action of a pole on any length of conductor conveying a current, or conversely of any circuit on a pole, can be made out from this; and it constitutes, therefore, another method of investigation which we might apply to the various special cases we have considered, but, of course, the results will be identical with those we have already obtained by the method of lines of force.

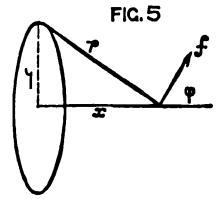
The two methods lead to the same result in every case; but the one method (Ampère's) simply states a law of action at a distance; the other (Faraday's) leads us to pay attention to what is going on in the whole space between the two bodies, and in which they are both immersed. Sometimes one method is the more convenient in practice, sometimes the other; but there can be no question about which is the truer to nature, because action at a distance is physically impossible.

As a simple illustration of the use of Ampère's formula, we may find the intensity of the field at the centre of a circle of radius y conveying a current. We suppose unit pole at the centre and find the force on it (see definition of "intensity"). So in this case $m = 1$, $\theta = 90°$, r is constant for every part of the circle and equal to y; the summing, therefore, refers simply to the length, and the whole length Σds is $2\pi r$, hence the intensity is

$$\frac{2\pi\gamma}{y}.$$

Again, find the intensity at a point on the axis of the circle at a distance x from its centre.

FIG. 5



Here $\theta = 90°$, $r = \sqrt{(x^2 + y^2)}$ and is constant, $\Sigma ds = 2\pi y$; but the force of each element, since it acts at right angles to the line joining the element to the pole, will make an angle ϕ with the axis whose cosine is $\frac{y}{r}$. The horizontal component of the force f is the only effective one, the other being neutralised by the action of the opposite point of the circle; hence, the resultant intensity is along the axis, and equal to

$$\frac{\gamma \,.\, 2\pi y}{r^2} \cos.\phi = \frac{2\pi\gamma y}{r^2} \cdot \frac{y}{r} = \frac{2\pi\gamma y^2}{(x^2+y^2)^{\frac{3}{2}}}.$$

Both these important results in the theory of the galvanometer we will obtain next week by the other method.

Continuous Revolution of a Magnet Round a Current.

If we could get a single magnetic pole it would revolve round a current (in one of the current's lines of magnetic force) continually—the work done at each revolution being $4\pi\gamma m$.

But, as every magnet has two equal opposite poles which tend to revolve in opposite directions, no such revolution can ordinarily take place. A flexible magnet would, however, by reason of the opposite action of its two poles, wrap itself tightly round the conductor conveying the current, like the thread of a corkscrew.

If one pole of the magnet is fixed by a ball-and-socket joint, or other plan allowing free rotation only, the other pole will begin to revolve round a circuit brought near it. It can start from one face of the circuit, and move round until it strikes against the other face, and is stopped. To make the rotation continuous we must have some plan of transferring the magnet bodily from one face to the other. This might be done in the case supposed by a sort of spring latch, against which the magnet should knock as it came round with sufficient force to open it, and let it pass through, the latch closing of itself directly the magnet was through. This, however, would have the disadvantage of interrupting the current just when the pole was in the best position to be acted upon by it. But various devices are known for permitting cross traffic to go on uninterruptedly, and one plan is to have a double bridge, one or other branch of which shall always be ready for road traffic, while the space between the bridges is sufficient to allow a boat to enter.

Similarly, the current can be split into two branches, each with a spring latch at the place where the magnet strikes them in its revolution. The magnet may now move continuously, not interrupting the current at all, but simply transferring it from the branch in front of the magnet to the branch behind it at each revolution. The magnet is thus transferred bodily from one face of the circuit to the other, and continuous rotation may now go on. (Faraday's device for accomplishing this was the ring trough, Fig. 4, Art. IV.) Notice that the magnet has to pass through the circuit without its axes being cut. It is not the mere accidental rigidity of the steel that prevents the rotation; it would be equally stopped if the magnet were liquid, because the axes of the magnet are lines of force going in the opposite direction to the external lines of force,

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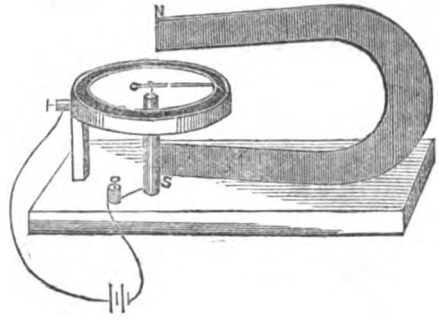
and would hence, if cut, tend to produce rotation in the other direction.

To produce continuous motion in any case, we must either use some of the magnet's external lines of force, and avoid the internal lines (or axes) altogether; or we must use the internal lines or axes of the magnet, minus as few as we can get of the external lines, which are in the opposite direction and help to weaken the action. As this is rather an instructive thing we will investigate a case further. Go back to the ring trough and revolving radial wire of Fig. 4, Art. IV. Call the length of this wire r. Then first suppose the rotation produced by the earth's vertical field V. The work done at each revolution will be $\gamma \pi r^2 V$, and hence the rotating couple is $\frac{1}{2} \gamma r^2 V$.

Next, consider the rotation produced by a horseshoe magnet with its north pole above the trough and its south pole at an equal distance below, the solid angle subtended by the ring trough at either pole (irrespective of sign) being ω.

FIG. 6.

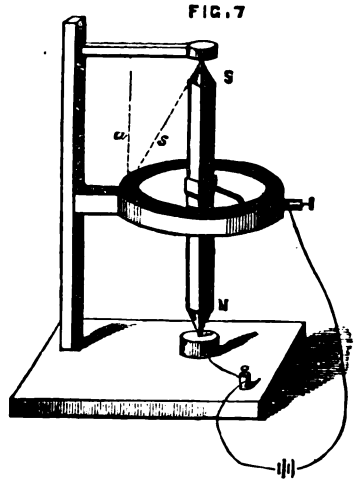


Then the number of lines of force passing through the trough is $m\omega$ from each pole; hence the work done at at one revolution is $2 m \omega \gamma$, and the rotating moment is

$$m \gamma \frac{\omega}{\pi}.$$

Finally, consider a bar magnet passed through the ring, with its north pole below and its south pole the same distance

FIG. 7



above, the whole being able to revolve with the wire. In this case the axes all pass down through the ring, their number being $4\pi m$, while external lines of force pass up in the other direction to the number of $2 m \omega$; hence the work done at each revolution is

$$m (4 \pi - 2 \omega) \gamma,$$

and the rotating couple is

$$m \gamma \left(2 - \frac{\omega}{\pi}\right).$$

In all these three cases the rotation will be in the same direction.*

* Observe that a magnet is not quite the same thing as two detached poles. In addition to the lines of force passing through the air from the north to the south pole, which two detached poles would have, a complete magnet has an equal number of lines (or axes) passing from the south to the north pole inside the steel.

The expressions for the last two cases may be put in another form by calling the plane angle subtended by r at either pole, θ; or the half distance between the poles a, and the slant distance $\sqrt{a^2 + r^2} = s$.

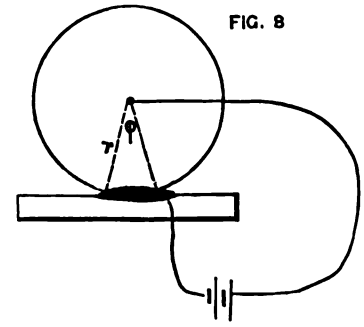
Then $$\omega = 2 \pi (1 - \cos. \theta) = 2 \pi \frac{s - a}{s}.$$

Hence $$m \gamma \frac{\omega}{\pi} = 2 m \gamma \frac{s - a}{s}, \quad . \ . \ . \quad \text{(the case of Fig. 6)}$$

and $$m \gamma \left(2 - \frac{\omega}{\pi}\right) = 2 m \gamma \frac{a}{s}. \quad . \ . \ . \quad \text{(the case of Fig. 7)}$$

So, when $s = 2a$ (that is when $\theta = 60°$, or when $\omega = \pi$) the two moments are equal, and it matters not whether detached poles are placed above and below, or whether a magnet is threaded through the circuit, with its poles in the same place.

FIG. 8



Again, consider Fig. 3, Art. IV., the rotating copper disc dipping into mercury. Let the arc touching the mercury subtend at the centre the angle ϕ (Fig. 8), and first place the disc east and west, so as to be subject to the earth's horizontal intensity H. The number of lines of force passing through the sectorial arc $\frac{1}{2} r^2 \phi$ is $\frac{1}{2} r^2 \phi H$, and all these are cut during rotation through the angle ϕ. Hence the couple is $\frac{1}{2} r^2 H \gamma$; and, so long as the field of force is uniform, the value of ϕ is immaterial, except as affecting the friction. Hence the mercury should only be allowed *just* to touch the disc.

Another symmetrical case would be obtained by making the axis, on which the disc revolves, a magnet; and from this also ϕ would disappear. But, in the ordinary case, when a horseshoe magnet is put with one pole on each side of the disc in a quite unsymmetrical position, we cannot say that the action is quite independent of the value of ϕ. In this general case, if ω is the solid angle subtended by the sectorial area $\frac{1}{2} r^2 \phi$ at either pole, the work done while the disc rotates through the angle ϕ is $2 m \gamma \omega$, and the couple is

$$2 m \gamma \frac{\omega}{\phi}.$$

Now, the general value of ω is a troublesome thing to obtain, but it is roughly proportional to ϕ when ϕ is small.

For the case to which an approximation is ordinarily attempted in practice, when the two poles of a horse shoe magnet are brought very near the mercury edge of the disc, the solid angle subtended by the sector $\frac{1}{2} r^2 \phi$ is pretty nearly half a lune, of angle ϕ, whose area on the unit sphere is ϕ; wherefore the couple in this case is simply $2 m \gamma$.

PROFESSOR DEWAR ON THE ELECTRIC ARC.

The former researches of Professor Dewar on the electric arc have been noticed in *The Electrician*, and we now propose to give some account of his latest investigations into this interesting subject. His recent aim was to see if there were any peculiarities of pressure in the arc. Such peculiarities might be caused by the motion of the gas particles, the transit of carbon from pole to pole, electrical action, or the chemical combinations taking place in the arc. To measure the pressures in the arc he employed a very sensitive manometer, which could measure the one-hundredth of a millimeter of water pressure. The readings of the experiments were necessarily complicated by the indirect action of the hot currents of air passing by the poles, and also by the irregular flickering of the arc. But by multiplying the trials and varying

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their conditions, he succeeded in eliminating these secondary effects and securing good results.

The apparatus employed consisted of two hollow carbons forming the poles of the arc, and the manometric device.

The carbons were similar in shape to those used by Professor Dewar in the separation of cyanogen from the arc. They were rendered non-porous by being placed in a porcelain tube and heated white hot in a current of coal gas saturated with vapour of benzole. This treatment causes the deposition of a layer of carbon in their pores, and renders them capable of withstanding a considerable interior pressure of air or other gas without exhibiting leakage. The hollow poles were connected by means of tubing with two manometers. These tubes were of metal or thick india rubber, sheltered from the heat of the arc by tin screens, through which a current of water continuously flowed. Ether was used in the manometer, because of its extreme mobility, and one millimetre of movement of the fluid in the horizontal tube was found to correspond to about 1-250th of a millimetre of water pressure.

When the arc passes between two pointed carbon poles, it assumes two very different forms; in one case the envelope of the intensely heated gases is well defined, almost spherical in shape, and surrounding the whole end of the positive pole, but touching the negative only at a single point without showing that close adhesion to the pole which is so characteristic of the layer of gas at the positive pole. At other times the arc is very unsteady, noisy, with blasts of green flame-like ejections, generally from the positive pole. These blasts are invariably associated with a great increase of intensity in the hydro-carbon and cyanogen spectrum. While the arc is in this unstable condition manometric results are impossible, as the small area of the carbon tube is rarely covered by the arc, so that the manometers often record neither positive nor negative pressures during the discharge. During the maintenance of the *steady arc* the manometer connected with the positive pole exhibits a fixed increase of pressure corresponding to a motion of the fluid in the horizontal tube of the manometer employed of from 50 to 150 millimetres, which is equivalent to from 1 to 2 millimetres of vertical water pressure in different experiments and under varied conditions. The manometer connected with a negative pole shows no increase of pressure, but rather a diminution.

When the arc begins to hiss the pressure on the positive pole instantly diminishes, and when blasts are ejected from that pole towards the negative pole the negative manometer, before at zero, showed a marked increase of pressure. When the current was reversed in the circuit by a commutator the arc was not broken, but the manometers immediately recorded a reverse action. The experiments were made by means of a Siemens machine, but a 70 cell Grove battery produced similar results. The horizontal arc was employed because it was fresh from air currents, but the vertical arc had the same general effect. It, therefore, appears that the gaseous envelope of the electric arc always shows a fixed permanent pressure amounting to about 1 millimetre of water above that of the surrounding atmosphere. This looks as if the luminous boundary of the arc had a small surface tension.

EARLY FORMS OF THE BELL TELEPHONE.

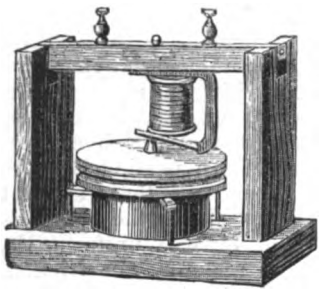

Fig. 1.

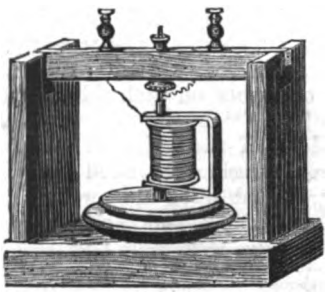

Fig. 2.

Fig. 4.

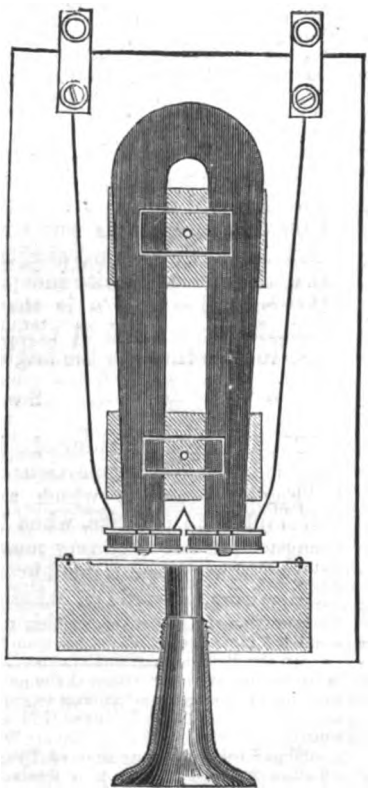

Fig. 5.

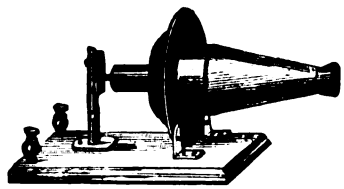

Fig. 3.

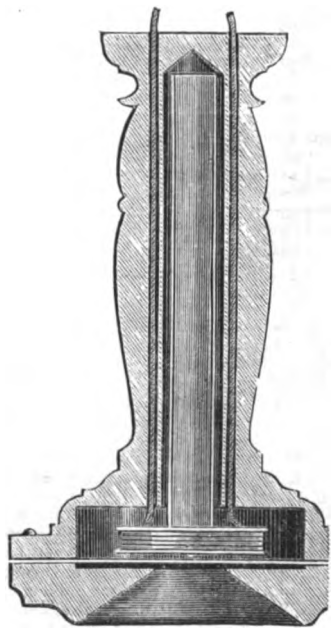

Fig. 6.

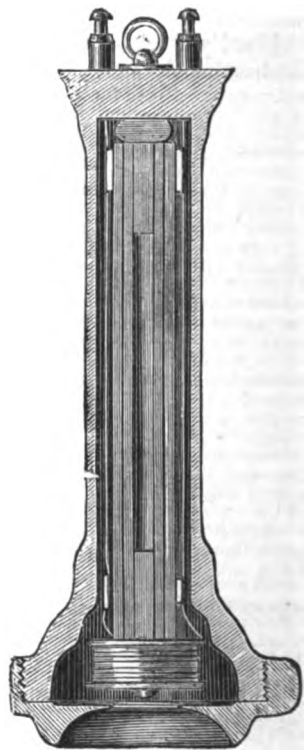

Fig. 7.

In connection with the lawsuit reported in page 207, it may be interesting to many of our readers to study the early forms of telephone as invented by Graham Bell.

Fig. 1 shows the first means of transmitting speech patented by Bell in the early part of 1876.

Fig. 2 shows a slight modification of the above which he adopted later in the same year.

Fig. 3 is an illustration of the telephone shown by Bell at the Philadelphia Exhibition, in June, 1876.

Fig. 4 shows the form of receiver used with the above transmitters, which was also exhibited at Philadelphia in 1876.

Fig. 5 represents the modifications introduced in June, 1877, to intensify the sounds—viz., the use of a horseshoe magnet and a thin iron diaphragm. Whilst

Fig. 6 illustrates the first hand telephone, which was constructed some months previous to the above—viz., in May, 1877.

Fig. 7 gives an illustration of the perfected hand telephone, constructed in December, 1877.

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THE TELEPHONE CASE.

This case, as is well known to our readers, was brought by the United Telephone Company against Alexander Maclean, of Edinburgh, for the infringement of Patent 2,909, July, 1877, of Mr. Edison, and Patent 4,765, December, 1877, of Mr. Graham Bell, granted to Mr. Morgan Brown. To the statement of facts by the United Company, Mr. Maclean admitted that no license had been granted to him for making, &c., the instruments described in these patents, also that certain telephones had been fitted up by him in the office of Messrs. Millar, Robson, and Innes, S.S.C., and refused upon application to discontinue the making and sale of such instruments. His defence stated the claims of Edison to be reduced by disclaimer to three, viz., 1st, in an instrument for transmitting electric impulses by sound, a diaphragm or tympanum of mica, substantially as set forth; 2nd, in an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympanum of electric tension regulators, substantially as hereinbefore described, for varying the resistance in a closed circuit, substantially as set forth; 3rd, the method herein specified of recording the undulations of the diaphragm or yielding material, and the reproduction of sound by such material acting upon a diaphragm to communicate to the same vibrations similar to the original ones, substantially as set forth; that the invention was not new, having been described by Reiss in 1863, and was used in 1871 at the office of the Submarine Telegraph Company, 58, Threadneedle-street, and previously in France, Russia, Austria, &c.; that the invention was also claimed by M. Clerac, and was exhibited at the Vienna Exhibition in 1874. With regard to the patent granted to Mr. Brown, Mr. Maclean stated that descriptions of the instrument were published in a number of papers in 1876. It would be uninteresting to give a verbatim report of the trial. The decision of the judge (Lord M'Laren), which we give, fully sums up the evidence in a most able manner.

Lord M'Laren said: In this case interdict is sought at the instance of the United Telephone Company against the infringement of two patents for telephonic instruments, the first being the original telephone invented by Mr. Graham Bell, and patented in this country in the name of Mr. Morgan Brown; the second being the transmitting instrument invented by Mr. Edison, and patented in his own name. The title of the complainers to these patents is set forth in their statement of facts, and is not denied. The question is whether the instruments which, according to the evidence, were supplied by the respondent to a professional firm in Edinburgh constitute an infringement of the complainers' patents, or either of them? It is alleged that the respondent used Edison's transmitting instrument and Bell's receiving instrument. With respect to Bell's invention, the defence is that the patent was anticipated by the premature publication of the invention before the letters patent were taken out. With respect to Edison's patent, there are two defences: (1) an objection to the patent itself, founded on an alleged discrepancy between the provisional and the complete specifications; (2) a denial that the respondent's transmitting instrument involves the use of Edison's invention. I shall deal with the cases in the order of discovery, beginning with the invention of Mr. Bell. The specification of William Morgan Brown, in which this invention is described, is divided into various "plans," which contain respectively the descriptions of different instruments, or different variations of the same instrument, adapted for the transmission and reproduction of vocal sounds through the agency of the electric force. But the only instruments or modes of application of Bell's invention referred to at the trial were the instrument described in plan fourth, and the two instruments or modes of application which are described in plan fifth. I shall state as briefly as may be the essential parts of Mr. Bell's invention, and shall consider whether the invention is disclosed by the alleged anticipatory publication with such distinctness as would be necessary to enable a person of skill to make the instrument, and to put it into effective operation. The essential parts of Bell's invention appear to be (1) a tympanum or circular plate of steel, or other metal susceptible of inductive action, for receiving the air pulses or undulations of speech; (2) the transmission in a closed circuit of electric undulations of the same order, induced by the vibration of this metal plate or tympanum; (3) the production of a repetition of the spoken sounds at the distant station or termination of the line wire by means of another metal tympanum, which, through "induction" or electric agency, is made to vibrate in the same manner as the first-mentioned tympanum, and thus to reproduce the vocal sounds in facsimile. All the witnesses are agreed that, under Bell's process, the transmission of the electric undulations along the wire is continuous. These undulations represent variations of the electric current corresponding to the variations of the elastic medium thrown into vibration by the voice, and like these they are continuous, because the electric force is transmitted from one station to the other in a closed circuit continuously, and without break or interruption; this is, in truth, the principle of Mr. Bell's invention—the transmission of undulatory electricity in a closed circuit. Mr. Bell discovered that electric undulations resembling those produced by speech could be transmitted through a closed circuit, and his specification (Morgan Brown's) describes different instruments and modes of operation for producing this result in a manner which is admitted to be clear and intelligible. It is also established that telephones constructed according to Bell's method were extensively used, and were of great utility. I now come to the alleged anticipation of the invention through the publicity given to Bell's discovery by Sir William Thomson in his address to the British Association delivered in August or September, 1876. Sir William Thomson, in his evidence in this case, stated that he was present at the performance of Bell's experiments on the occasion of a visit to the International Exhibition at Philadelphia, and that he heard the instrument repeat the phrases of Hamlet's soliloquy, which he quotes in his address. Mr. Bell, treating Sir William Thomson with the confidence accorded to a scientific visitor of distinction, had shown him his apparatus, explained to him the principle of his invention, and presented him with models or copies of his transmitting and receiving instruments. Sir William Thomson, in the passage of his address to the British Association, gave an account of Bell's discovery, and he also exhibited models of Bell's transmitting and receiving instruments. The object of the learned lecturer, however, apparently was to describe results rather than processes; and although inferentially he may have given some indication of the methods employed, I am satisfied that his address does not contain such a description of Bell's process as would, even with the aid of the models, enable a skilled operator to produce a working telephone on the principle of the specification. Such is the opinion I have formed, construing the passage in Sir W. Thomson's address as I should construe a specification, after informing myself as to the state of scientific knowledge on this subject at the time, and with all the aid which I have been able to derive from the evidence as to the meaning of the terms of art used in the address, and their application to the models. It is plain that the invention had not been perfected—was, indeed, only in the experimental stage—at the time when Mr. Bell explained his method to Sir William Thomson, and Sir William, in his address, did not profess to communicate anything more than he had received from Bell. Mr. Cooke, a witness for the respondent, thinks that he could have made the instrument from Sir William Thomson's description. But then Mr. Cooke is an electrician of more than ordinary skill, and against his view I have to set the statement of another electrician of not inferior skill, who, with superior advantages to those of Mr. Cooke, tried to produce articulate sounds with Bell's instrument, and failed. Besides, I must say that Mr. Bell's experimental instrument, as published by Sir William Thomson (if the address is held to amount to publication), differed most materially from the instrument as patented. First, the transmitting tympanum of the experimental instrument consisted of a stretched membrane or drum, carrying a steel armature. All the witnesses are agreed that such a tympanum is open to serious objection, and that it will not give results satisfactory or comparable to those given by a metal transmitter, as described in the specification of the patented invention. Secondly, the address does not state that the transmission of the electric force is to be made through a closed circuit, although this, as I have endeavoured to explain, is really the principle on which the successful working of the invention depends. It is true Sir William Thomson did not profess to describe any mechanical appliances for making and breaking the circuit; but it does not follow that his audience would draw the inference that the circuit was to be closed. He was not professing to give a full description of the mechanical appliances used by Bell. Nobody but Sir William Thomson and Bell himself knew that the transmission of the electric current was to be in a closed circuit, and yet the skilled operator, who is supposed to be able to work from Sir William Thomson's description, is left to find this out for himself. How was he to find it out, unless by the exercise of inventive talent; by, in short, re-discovering the principle of Bell's invention? Thirdly, the plate, or the tympanum, of the model-receiving instrument exhibited by Sir William Thomson, instead of being attached to the transmitting case by its circumference, so as to imitate the form of a drum, was attached by a screw at one point only. While thus attached it stood inclined at an angle to the mouth of the case, like the lid of a box slightly raised. In this position the plate would vibrate in the manner of the tongue of a tuning fork, and not in the manner of a tympanum. According to all the evidence such a receiving instrument would not repeat articulate speech. This brings me to the decisive part of Sir William Thomson's evidence. This gentleman, himself the most eminent electrician in the United Kingdom, possessed of the instruments furnished by Mr. Bell, and instructed by Bell as to their principle and mode of application, was unable to make them work so as to reproduce articulate speech. As to the suggestion that a skilled operator would have found out the mode of operation when he came to use the instrument, I may observe that, according to patent law, an invention is not sufficiently described if experiment be requisite to enable a skilled operator to discover the mode of working it; and after being told by Sir William Thomson that his scientific knowledge, aided by personal communication with the inventor, did not lead him to infer that the tympanum should be kept down in order to the production of the desired result, I cannot for a moment suppose that this inference is one that should be drawn by an ordinary workman working by the description contained in Sir William Thomson's address. I pass to Edison's patent; and, first, as to the objection founded on the discrepancy between the provisional and the complete specifications. The complete specification describes various telephonic instruments, and, amongst others, an instrument known as the phonograph, which records the undulations of a vibrating diaphragm or tympanum by indenting a series of dots on a cylinder, covered with tinfoil, and made to revolve rapidly by clockwork. In the reverse or complementary action of the instrument, the sounds may be reproduced with more or less distinctness by giving to another diaphragm the motion resulting from a steel point vibrating in contact with the series of indentations. The invention includes two process—first, the recording of the sounds on a sheet of tinfoil; secondly, the reproduction of the sound by means of mechanism set in motion by the indentations on the tinfoil. It is said that the provisional specification discloses only the first of these two processes; and that the patent is void, because in the complete specification the reproduction as well as the recording of the sound is claimed. This is an extremely critical objection, and I do not think that it is well founded. There remains for consideration the question of the identity of the respondent's transmitting instrument with the transmitting instrument described in Edison's specification—a question of some difficulty, though I have ultimately formed a clear opinion regarding it. In the Bell telephone the electric undulations set up in the line wire were comparatively weak, and the echo or reproduction of the voice at the distant or receiving station was correspondingly faint, so faint that the telephone could only be used within moderate distances. Mr. Edison's efforts were directed to the discovery of a method by which the waves of sound should operate more powerfully on the electric current, and this he effected by a process which is described by electricians as the method of "varying the resistance" to the electric current in the course of its transmission through a closed circuit. This was accomplished by making a joint in the circuit near to the transmitter, so that the current should at this point pass from one surface to another surface in contact with it under pressure. According to Mr. Edison, one of the two surfaces in contact ought to be a semi-conductor; and plumbago and some other forms of carbon are indicated as the most suitable materials for the purpose. According to his description, the variations of pressure between the surfaces, consequent on the vibrations coming from the tympanum, induce variations in the electric current proportionate to, but greatly exceeding in magnitude, the variations which would be induced by the direct action of the air waves according to Bell's method. According to Edison's theory, his process is in the strictest sense a mode of working in a closed circuit,

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because the carbon surface, although mechanically disunited from the platinum or other surface on which it presses, is nevertheless in electrical contact with that surface. There is, therefore, no making and breaking of the electric circuit as in the earlier tentative methods, but a continuous current of undulatory electricity, the number and form of the waves being determined by the change of pressure upon the carbon surface. It does not appear that any of the mechanical combinations described in the specification ever came into commercial use, probably because, as may happen in the history of even the most original and valuable inventions, these were immediately superseded by simpler constructions involving the same principle. It was soon found that no special precautions were needed to prevent the separation of the surfaces constituting the tension regulator. I am informed that Mr. Edison now uses a carbon button placed between two plates of platinum, without the agency of a spring or mechanical pressure to hold them together. In the respondent's instrument, against which the interdict is directed, the variations of resistance to the electric current are produced by the contact of two surfaces of gas carbon, one of them being loaded with a piece of brass, and suspended obliquely, so as to press slightly against the other. To these pieces wires are attached, and the current passes through them. This is said to be a different instrument from Edison's, both in principle and construction. It is said that Edison aimed at varying the resistance in the line by the compression of a fibrous material throughout the mass, and not by the vibration of pressure at the surface of contact. Again, it is denied that the operation of the respondent's instrument depends on pressure. It is said that in his instrument the two carbons re-act on each other, in the manner of rigid, non-elastic, incompressible substances, and that, instead of the electric current being merely varied, under the influence of vibration, as the surfaces of carbon tend alternately to approach and recede from each other, the electric current is actually broken at each vibration. According to the respondent's theory, his instrument is not an example of the action of undulatory electricity in a closed circuit, but is an extremely delicate "make and break" of the current, so delicate and instantaneous (if I rightly understand) that the undulations are virtually, and in their acoustic effects, equivalent to continuous vibrations. It would probably not be satisfactory to the parties if I should abstain altogether from offering an opinion on this interesting scientific question. But I think it right to say at once that, in the view I take, its solution cannot affect the decision of the case. Because, in my opinion, it is apparent, at least in the present state of scientific knowledge, that the principle and mode of action of Edison's tension regulator and that of the respondent is one and the same. If the respondent's surfaces vary the resistance by a "make and break," so must Mr. Edison's. Nothing is more clear upon the evidence than that the wonderful and hitherto unexplained responsive action of the electric force to vibrations propagated through surfaces in loose contact depends neither on the form of the surface nor on the mode or amount of pressure, although some forms of contact and of pressure certainly give better results than others. Mr. Edison's methods have this in common with the respondent's—that they produce similar phenomena under every mode of bringing semi-conducting surfaces into contact in an electric circuit, and until some distinction is shown to exist similar phenomena must, in my opinion, be referred to one and the same general law. Even if Mr. Edison were held to be in error in supposing that his method was that of a closed circuit, yet if it is a useful invention, and if it is sufficiently described for practical purposes, it is no objection to his patent that he has used language which would be scientifically inaccurate according to the present state of knowledge. While for these reasons I hold that, in any view of their mode of action, the principle of the respondent's instrument is identical with Edison's, I must also hold that the weight of the evidence is in favour of the accuracy of Edison's description of the principle of his invention as being that of a closed circuit. Another point urged for the respondent is that under his instrument a tympanum is unnecessary, because the carbon regulator, or microphone, as he prefers to term it, is sufficiently sensitive to be acted on by the direct pulsations of the air. Now, as Edison's patent is for a tension-regulator in combination with a diaphragm or tympanium, it follows that the interdict sought would not apply to the use of the respondent's carbon-regulator without a tympanum. But, in the instruments sold by the respondent, the sound is transmitted across a circular metal disc, interposed between the mouthpiece and the carbon-regulator, and although this metal disc is mounted on a sheet of cork, I have not the smallest doubt that it acts as a tympanum, and that it is a useful and necessary adjunct of the acoustic apparatus. The cork does not prevent the metal plate from being thrown into vibration by the voice, and it transmits the sound waves, possibly with some diminution of intensity and suppression of superfluous vibrations, to the carbon-regulator, whose function it is to react upon the electric circuit. It was contended by the respondent's counsel (if I rightly understood) that the cork plate would have the effect of entirely stopping the waves of sound; but this proposition appears to me to be untenable in view of the well known fact that sound waves are transmitted through the earth over distances measured by hundreds of yards, or even miles, traversing in their course substances of the most various density and elasticity. Being satisfied that the respondent's instrument is an application of the principle of Edison's tension-regulator, and that it involves the combination of a tension-regulator with a tympanum, I have only to consider whether the instrument itself is distinct from anything described by Edison, or is an imitation or mechanical variation of his invention. However unlike any particular variation may be to those which are described in the specification, yet if the contact is that of a semi-conductor of electricity, and is used in a telephone for the purpose of varying the resistance to the electric current in the line, I am of opinion that it is a form of Mr. Edison's invention, and that the words of the specification are broad enough to cover it. In the particular case the respondent's form appears to possess such merit that it might have been patented as an improvement upon Mr. Edison's tension-regulator; but that, of course, would imply that it could not be used without Mr. Edison's licence. It follows from this opinion that the complainers are entitled to protection by interdict under Edison's as well as Bell's (or Morgan Brown's) patent.

Counsel for the complainers, the United Telephone Company—Lord-Advocate, Solicitor-General, and Mr. C. S. Dickson. Davidson and Syme, W.S., agents.

Counsel for respondent—Mr. Macintosh and Mr. Salvesen. Boyd, Macdonald and Jameson, W.S., agents.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

Directors' report for the year ended December 31, 1881, to be presented at the eighteenth ordinary general meeting of the shareholders, to be held at the City Terminus Hotel, Cannon-street, London, on Tuesday, 14th February, 1882, at twelve o'clock noon.

The net profit on the Company's business for the past year, as shown in the annexed accounts, is £77,226 1s. 7d. Adding £8,280 3s. 8d. brought forward from 1880 and £7,820 12s. 6d. profit on securities realised and dividends, and deducting £15,600 interim dividend paid in July, there remains a disposable balance of £77,726 17s. 9d. Of this balance the directors have added £25,000 to the reserve fund, raising it to £100,000; and they now recommend the distribution of £1 per share, amounting to £31,200, making a total dividend for the year of 15 per cent., as against 12½ per cent. for 1880, free of income-tax, carrying forward £21,526 17s. 9d. to the credit of the current year. The general sales, at Silvertown and at Persan, show an increase of about £21,500 compared with 1880, the Company having been busy in most departments at both works. By improvements which have increased the facilities at Persan, the Company has been enabled to undertake contracts for subterranean telegraph cables in France. In August the directors obtained a contract from the Central and South American Telegraph Company, of New York, for 3,082 nautical miles of cable to connect Vera Cruz in Mexico with Callao in Peru, with stations at the principal Central and South American ports. The Vera Cruz section was sent out in this Company's steamship "International," and was successfully laid last month. The Company's steamship "Dacia," with 813 miles of cable to be laid in the Pacific, reached Callao last month, and is at work. The steamship "Silvertown" (late the "Hooper"), which the directors purchased in November, will sail for the Pacific this month with the remainder of the cable. These cables will unite those made and laid by this Company for the Mexican and West Coast of America Telegraph Companies, the whole consisting of about 5,400 miles, and will complete an important direct line between Valparaiso and New York. Of the other cables made by the Company during the year may be mentioned 300 miles for the West India and Panama Telegraph Company, seventy of heavy cable for the Great Northern Telegraph Company, and shorter lengths for the Submarine and Direct Spanish Telegraph Companies. The Company's staff and steamships were engaged in cable repairs during the year for the International Ocean Telegraph Company of New York and for the Postal Department of Her Majesty's Government. Dr. Beattie, who retires by rotation, offers himself for re-election as a director.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Feb. 8.		Business Done Week Ending Feb. 8. Highest.		Lowest	
Anglo-American	50,	51	.....	51	.....	50
Do. Preferred	78½,	79½	.....	79	.....	78
Do. Deferred	21½,	22½	.....	22½	.....	21⅝
Brazil Submarine	11,	11½	.....	11½	.....	11
Cuba	8½,	9	.....	8⅝	.....	8 9-16
Do. Preference	15½,	16½	.....	—	.....	—
Direct Spanish	5,	5½	.....	—	.....	—
Do. Preference	14½,	15½	.....	—	.....	—
Direct United States Cable	10⅜,	10½	.....	10½	.....	10⅜
Eastern Telegraph	9⅞,	10⅛	.....	10	.....	9⅞
Do. 6 per Cent. Preference	12½,	12¾	.....	12⅝	.....	12⅝
Do. 5 per Cent. Debentures, 1899	102,	107	.....	—	.....	—
Eastern Extension	10⅞,	11¼	.....	11	.....	10⅝
German Union	9⅛,	9⅜	.....	9⅛	.....	9⅛
Globe Telegraph and Trust Company	6,	6½	.....	6½	.....	6½
Do. Preference	12½,	12½	.....	12½	.....	12½
Great Northern	11½,	12	.....	11⅞	.....	11⅞
Indo-European	28,	29	.....	28½	.....	28½
Mediterranean Extension	2⅛,	2⅜	.....	—	.....	—
Do. Preference	9⅛,	9¼	.....	—	.....	—
Reuter's	12⅛,	12½	.....	—	.....	—
Submarine	270,	280	.....	—	.....	—
West India and Panama	1⅜,	1½	.....	1⅜	.....	1⅜
Do. 1st Preference	7⅞,	8⅛	.....	7 15-16	.....	7⅞
Western Brazilian	8⅛,	9	.....	9	.....	8⅛
West. Union 7 per Cent. 1st Mortgage	123,	128	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	104,	107	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1¼	.....	1¼	.....	1⅛
Oriental	⅛,	¼	.....	9-16	.....	⅛

ELECTRIC LIGHT.

Electric Light and Power	1,	1¼	.....	1 3-16	.....	1
Anglo-American Brush	9,	9½	.....	9⅜	.....	8½
United Telephone	11½,	12¼	.....	12¼	.....	12

TRAFFIC RECEIPTS FOR JANUARY, 1882.

Companies.	Jan., 1882.	Jan., 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,800	2,527	273	—
Direct Spanish Telegraph Company	2,055	1,506	549	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,129	29,434	3,695	—
Eastern Telegraph Company	53,648	47,445	6,203	—
Great Northern Telegraph Company	16,960	17,353	—	393
London-Platino Brazilian Telegraph Co.	1,868	1,990	—	122
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

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SLIP

SUBMARINE TELEGRAPH COMPANY.—The next half-yearly meeting of this company will take place on the 22nd inst.

ELECTRIC LIGHT AT LOWELL (MASSACHUSETTS).—We hear that an electric light company has been organised in this town.

ELECTRIC LIGHT IN CHURCHES.—American news says that electric lights have been introduced into a church at Troy, New York.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended the 10th inst. amounted to £4,323.

A CONUNDRUM.—Why is the letter B a remarkable illuminator?—Because it transforms a rush-light into a Brush-light.—*Provincial paper.*

GREAT NORTHERN TELEGRAPH COMPANY.—This company's cables between Shanghai and Amoy and between Amoy and Hong Kong are interrupted.

ELECTRIC LIGHT AT BIRMINGHAM.—It is proposed to light the Town Hall during the coming musical festival at Birmingham by means of the electric light.

THE ELECTRIC LIGHT IN AMERICA.—It is stated that the Grand Trunk Railway Company is introducing the electric light into its Point St. Charles workshops.

SS. "INTERNATIONAL."—The India Rubber, &c., Works Company's cable ship "International" was expected in the river to-day (Saturday) on her return from Mexico.

SS. "DUCHESS OF MARLBOROUGH."—The latest news of this cable-repairing vessel was that she had arrived at Georgetown (British Guiana), and was about to repair cables there.

AMERICAN TORPEDOES.—It is announced that the makers of electrical torpedoes in America have formed a consolidation of all their interests, and are about to establish works near New York.

THE ELECTRICAL TRADING COMPANY.—The formation of this company is announced, with a capital of £10,000, in £10 shares. Its objects are to manufacture electric metres of all kinds, and other apparatus.

NEW COMPANY IN AMERICA.—The Fisher Electric Company, of Union City, Ind., has been formed. The capital is 5,000,000 dols., and the object is to manufacture, sell, and lease electric light apparatus.

THE BRUSH LIGHT IN NEW ORLEANS (U.S.A.).—Brush electric lights have been introduced into some of the principal thoroughfares of this town by the South Western Brush Electric Light Company.

HOUSE OF COMMONS.—On Monday next Sir J. Hogg will ask the President of the Board of Trade what course the Government intend to pursue with reference to the various Bills relating to electric lighting.

ELECTRIC LIGHT FOR SAINT-ETIENNE (FRANCE).—It is proposed to light this town, which is situate in the Loire Department, by means of the electric light. The power for generating the electricity is to be obtained from the Furens Falls.

ROYAL SOCIETY.—On Thursday last a paper was to have been read before this society by Messrs. A. Waller, M.D., and A. de Watteville, M.A., on "The Influence of the Galvanic Current on the Excitability of the Motor Nerves of Man."

ELECTRIC LIGHT AT PHILADELPHIA.—An addition of 60 Maxim incandescent lights has lately been made in the Philadelphia Post Office. They were used for the first time on the 24th January, and are said to have given great satisfaction.

MAXIM LAMPS IN FACTORIES.—The Enterprise Factory at Augusta, Ga., has introduced the electric light in place of gas made from gasoline. In the weaving room seven Maxim lamps have replaced 132 gas burners.—*Sanitary Engineer* (New York).

WESTERN BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended the 10th inst. amounted to £2,749, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

SS. "MORNA."—This cable-repairing vessel arrived at Stromness, in the Orkney Islands, on Friday of last week. It is reported that she is to lay a cable of a heavy type in the Pentland Firth, which shall be capable of withstanding the violent seas of that locality.

CABLES OF THE WORLD.—According to a recent estimate the total length of submarine cables in the world is 62,100 miles. Putting the average cost, including stations and vessels, at £643 12s. a mile, we get a total value of nearly £40,000,000 (forty million pounds).

THE TELEPHONE FOR BUCHAREST (ROUMANIA).—M. Floru, Inspector-General of Roumanian telegraphs, has been deputed by his Government to visit Berlin and report upon the telephonic system at work there, with the view of establishing the telephone in Bucharest.

SS. "SILVERTOWN."—This cable vessel, belonging to the Indiarubber, &c., Works Company, is at present in the Galleon Basin of the Albert Docks, completing the necessary alterations to her cable machinery and cabin fittings. She has 2,300 nautical miles of cable on board.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting of this society will be held at the Institution of Civil Engineers on the 23rd inst., when a paper will be read on "Siemens' System of Railway Gong-Signalling" by Mr. R. Von Fischer Treuenfeld, member.

ELECTRIC LIGHTING FOR THE CHANNEL TUNNEL.—Six electric lights are now used to light up the half mile of tunnel already bored at Shakespeare Cliff, Dover. The new light is so superior to the ordinary candles and lamps, that a great increase in the progress of the work has been made.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company, subject to the audit of the accounts, propose paying a dividend of 15 per cent. (£1 16s. per share) in addition to the ad interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1881.

SIXPENNY TELEGRAMS IN BRITISH GUIANA.—News from the West Indies reports the recent introduction of a sixpenny telegram system into British Guiana as a success, the messages being nearly three-and-a-half times as many as during the time that the minimum charge was one shilling.

CRYSTAL PALACE ELECTRICAL EXHIBITION.—Arrangements have been made with Professor Sylvanus Thompson for a series of evening lectures "On Electric Currents and Electric Lights," to be delivered on Wednesday evenings, February 22, March 1, 8, and 15, in connection with this exhibition.

CENTRAL AND SOUTH AMERICAN CABLE.—The India Rubber, Gutta Percha, and Telegraph Works Company have

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received a telegram from Mr. W. Falconer King stating that the ss. "Dacia" had successfully landed the two shore ends of the Central and South American Telegraph Company's cables at Payta (Peru).

THUNDERSTORM IN THE ORKNEYS.—On Tuesday morning a terrific gale from south-west, veering north-west, with heavy falls of snow, accompanied by most vivid flashes of lightning and loud peals of thunder, was reported from Kirkwall, the thunder being said to be the loudest heard for many years. Telegraphic communication with Shetland was interrupted.

FRENCH ACADEMY OF SCIENCES.—In his address to this Academy, at the annual meeting on the 6th instant, M. Wurtz, the president, alluded to Professor Graham Bell as having obtained the Volta prize, and M. Planté the Lacaze prize for physics. It may be mentioned that the latter gentleman has given the money, some 10,000 francs, to the Société des Amis de Sciences, founded by Thénard.

TELEGRAPHS IN CANADA.—News from Montreal says that the Canada Mutual Telegraph Company completed the erection of a line between Montreal and New York, on the 25th ult. The line between Toronto and Buffalo is also completed. Wires between Montreal and Ottawa will be working by the opening of Parliament. The system will be open to the public during the early part of the present month.

CONTRACT FOR MORSE PAPER.—The contract to supply Her Majesty's Government and the Post Office with printing papers in endless coils, for the Morse and Wheatstone instruments, has been secured by Messrs. Waterlow and Sons (Limited), of London-wall, and Finsbury Stationery Works, E.C. The contract comprises in the aggregate about 700,000 coils of paper, weighing 170 tons, and upwards of of 156,000 miles in length.

SIXPENNY TELEGRAMS.—At a Glasgow Chamber of Commerce meeting on Monday a resolution was carried to the following effect, viz.: — "That this Chamber resolves to memorialise the Postmaster-General for the reduction of inland telegrams to the rate of 6d. per message of 12 words, including the address of the sender and the receiver, with a uniform charge of ½d. per word beyond the first 12 words, or such modification as circumstances justify."

EDINBURGH ARCHITECTURAL ASSOCIATION.—Dr. Ferguson, of the Queen-street Institution, Edinburgh, delivered a lecture before the above Association last week, on "Lamps and Lighting." In the course of his lecture Dr. Ferguson showed Swan, Werdermann, and Brush lamps in operation, as types of the incandescent, semi-incandescent, and arc lamps, and expressed himself in favour of electric lighting, if a suitable method of storing electricity could only be found.

THE EDISON LIGHT FOR RIO DE JANEIRO.—Mr. Edison's representatives in Rio de Janeiro having petitioned the Government to appoint a commission to report on the Edison system of house illumination, the Minister of Agriculture, Commerce, and Public Works has consented, nominating Councillor Capanema, of the Telegraph Department, and Councillor Galvao, Inspector of Gasworks, who also since his appointment thereto has been posting himself in electric lighting.

ELECTRICIANS IN THE CITY.—According to the day census of the City of London, taken in April last, there were at that date sixty-four persons engaged in electrical work in the City. This figure includes electricians, electric light engineers, electrotypers, and electroplaters. The census is published by Longmans and Co., and is very interesting reading for those who care for statistics. The above figure does not, however, include telegraph engineers, who are included under the head engineers. Were these and telegraphists to be added the total would be a much larger one than that given.

EDISON ELECTRIC LIGHT IN MILAN.—*La Perseveranza* of Milan announces that Mr. James Shepherd, representative of the Edison Electric Light Company in Italy, has fitted up the *Salone del ridotto della Scala* in Milan with 92 incandescent lamps in place of the same number of gas burners. The new light is said to give great satisfaction. It is understood that this experiment is to enable the municipal council to judge of the adaptability of the new light for the illumination of the theatre. In the erection of the lamps, &c., Mr. Shepherd was assisted by Mr. Acheson, of the Edison Company.

THE TELEPHONIC SERVICE OF PARIS.—In an interesting article, descriptive of the general arrangements of the telephonic service of Paris as carried out by the Société Générale des Téléphones, our contemporary, *La Nature*, states that almost the whole of the wires, with some trifling exceptions, are carried in the sewers, and that the metallic circuit, a return wire being used, is universal. At the conclusion of the article the names of some of the *personnel* are given, two at least of which sound very English. They are—MM. Lartigue, manager; Berthon, engineer; Brown, electrician; and Gilquin, manager of the factory.

THE MICROPHONE AND SONOROUS VIBRATIONS.—Signor Serra-Carpi has made further experiments with the microphone for determining the nodes and ventral segments of vibrating columns of air (see *The Electrician*, Vol. VIII., p. 194). He finds that the passage of the microphone through a node or a ventral segment in a sonorous pipe can be rendered visible by means of a galvanometer. When the microphone traverses a node, the galvanometer indicates the passage of a current; when, on the contrary, it traverses a ventral segment, the needle oscillates equally in both directions, because with low notes there is no circulation of current.

TELEGRAPHS OF JAMAICA.—The telegraphic system of this colony has during the last year or two been freely extended, with the most beneficial results. The circuit of the island was only completed in March last. The number of messages transmitted between the end of October, 1879, and September 30, 1880, was only 17,453. During the corresponding year ending September, 1881, these numbers increased to no less than 40,859, although some of the offices, including that at Port Royal, have only been very recently opened. This progress promises even still further development, for during the month of November 5,215 messages were sent—equivalent to over 62,000 annually.—*Colonies and India.*

ELECTRIC LIGHTING FOR TRAINS.—In a recent number of the *Zeitung des Verlins Deutscher Eisenbahnverwaltungen* the question of electric lighting for trains is gone into, and surprise expressed at the dilatoriness of German railway officials in the matter. It says that the German Post Office are considering whether they shall light their travelling post offices by this means, but that at present they have gone no further. The *Zeitung* refers to a conference of railway officials which took place at Frankfort recently, at which the president of the Main Neckar Railway is reported to have said that his railway, not having adopted the gas lighting system, would not think of any other means of lighting but by electricity, the adoption of which by every company was, in his opinion, only a matter of time.

VARIATION IN THE RESISTANCES OF DYNAMOS.—M. Lodiguine writes to *La Lumière Electrique* for the 11th instant,

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stating that in Nos. 3 and 4 of the Russian *L'Electricité* for 1880, he published an article on the difference that existed in the resistance of the contact brushes of electrical machines when they were at rest and in motion. In this article he pointed out that the resistance of a contact, rubbing on the circumference of a wheel in motion, increases proportionally to the number of revolutions of the latter; in other words, it is proportional to the speed. He alludes to the experiment made by M. Lacoine on this head (see *The Electrician*, Vol. VIII., p. 115) as confirmatory of his own, and thinks that more attention should be paid to contacts in dynamos, since they at present detract greatly from the power of the machine.

Accident by Lightning.—A recent number of the *Melbourne Argus*, just to hand, says:—"A pleasure party had an extraordinary escape from death by lightning to-day (December 28). The party included Mr. W. L. T. Montefiore, Signor Ferrarini (the Italian artist), his wife, and Mr. Marsden. They were on a visit to the Blue Mountains, and when near Mitchell's Causeway were about to enter their buggy, when a blinding flash of lightning prostrated three of them. One of the horses was killed instantaneously, and the other was knocked down. Mr. Montefiore was the only one of the party who escaped unhurt. Signor Ferrarini felt the electric shock on his left side, and Signora Ferrarini on her right side. Mr. Marsden's left arm was temporarily paralysed. The party were subsequently enabled to travel as far as Blackheath."

Electric Light for St. Petersburg.—A proposition has been laid before the Municipal Council of St. Petersburg by a company styling itself the Electro-Technical Company, to light the Newsky Prospect, from Anitckow Bridge to the Grand Mosque, by electric light, for a small sum. The company to erect at least thirty electric lights, which shall be lighted and extinguished at the same hour as the present gas lights. The company proposes the following conditions, viz.: 1, That it be granted a concession for four years from the 1st January, 1882, with leave to utilise the present lamp-posts as supports for its wires for the present season, on condition that they shall hereafter be laid underground; 2, the right to lay wires and to introduce electric lights into the houses in the Newsky Prospect; 3, the right to establish electric motors either behind the Kazan Cathedral or in Michel-square.

A New Telegraph Line in Russia.—The first portion of a line destined to unite Yakoutsk, on the left bank of the river Lena, with the Siberian telegraph system, is to be undertaken this year. The new line is to be constructed between Irkoutski and Verkholensk, a distance of 272½ versts, during the year, and surveying operations are to be pushed on to Vitine, an important gold district. *La Lumére Electrique* says "that the construction of this line has long been contemplated, as it will open up a very important gold producing district. The local population have subscribed a considerable sum towards its construction, besides offering to find several thousand telegraph poles, and to construct, free of cost, certain telegraph stations. Irkoutsk, from where the line will start, is the capital of Western Siberia, and is distant about 3,000 versts from Yakoutsk. The country to be traversed by the projected line is said to be a very difficult one."

Electric Light and Photography.—At the Cantor Lecture on Photography, delivered by Captain Abney at the Society of Arts on Monday last, the lecturer demonstrated the sensitiveness of the green form of silver bromide, discovered by himself, to the heat rays of the spectrum, by taking a photograph of the carbon points of an electric light through a piece of ebonite. He next showed the extraordinary sensitiveness of the gelatine process by photographing a very rapidly rotating disc, having black and white sectors painted alternately upon it, by means of a single spark, five millimetres in length, from a battery of six small Leyden jars. The photograph showed the rotating disc seemingly without motion. Captain Abney stated the time taken for the passage of the spark to have been less than five millionths of a second. Finally, he showed the method of taking enlarged negatives and enlarged prints from small negatives by means of the electric light.

The Telephone in Germany.—With reference to the Note on page 193 of our last issue, in which we stated that the German Post Office had asserted that the establishment of telephonic communication between houses was a part of the Imperial monopoly, we take the following from the *Révue Industrielle* for the 15th inst. Our contemporary, after confirming the above information, says:—"The new service (telephone) has been handed over to the Reichs Postamt (Central Post Office). At present telephonic communication exists only in Berlin, Frankfort-on-the-Main, Hamburg, Manheim, Mulhouse, Breslau, and Cologne. The system will soon be introduced into Leipzic, Stettin, Magdebourg, Hanover, Altona, Elberfeld, Barmen, Strasbourg, Dresden, and Bremen. The Post Office has also promised to erect telephone lines in a large number of towns besides those given above. Berlin at present has 1,319 kilometres of telephone wires, and 159 receiving offices."

Telegraphs in Rio de Janeiro.—Approval has been given to the new telegraph regulations drawn up by Councillors the Viscount Bom Letiro, Lafayette, and F. E. Soares da Camara. The lines will be divided into two classes, the first comprising the lines connecting Rio with the provincial capitals and the frontiers; the second, consisting of branches and of lines radiating from Rio and the provincial capitals, is not to be undertaken until the first is completed, unless the provinces or others supply the means and become responsible for the working expenses. Where advantageous, signal stations will be established on the coast. All electric conductors excepting only those within private property will be under the supervision of the Director-General of Telegraphs, and be put up by his department, but worked at the cost of the concessionaires. The regulation also provides for the Administration of the Department of Telegraphs, and will supersede the one promulgated eleven years ago.

Risks Attaching to Electric Light Wires.—The New York Board of Fire Underwriters have made some changes in the rules concerning electric wires. For arc lights the conducting wires must have a weight equal to that of the wires forming the main circuit of the lamp regulator, or of the armature of the machine, if that is larger. For incandescent lighting the wires must never be unpleasantly warm by the passage of the current, and in no case must the wires be connected with the earth or with gas or water pipes. Exposed wires must be covered with two coatings, one of which must be waterproof if the wire is in contact with water. A switch must be provided at the point where the wires enter a building, to allow of its being "cut out" from the circuit in case of fire, and the two wires at this point must be at least one foot apart. Wires on walls and ceilings should not be nearer than eight inches to each other if for arc lights, and two and one-half inches if for incandescent lamps.

Asbestos Paint.—The recent burning of the Ring Theatre

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in Vienna has brought into prominence of late the fire proof properties of the "Asbestos paint" manufactured by the United Asbestos Company of Queen Victoria-street, and public trials of it have been made recently at the Crystal Palace with the most satisfactory results. Wooden sheds, gauze curtains, &c., when painted with this material, refused to burn. The Asbestos Company have, we understand, already painted the stage of the Crystal Palace Theatre. The paint is patented, and consists chiefly of ground asbestos in a liquid silicate. Being a non-conductor of electricity as well as heat, asbestos is likely to prove useful in electrical engineering, and Dr. Alexander Muirhead is, we understand, now engaged in testing whether it is adaptable to rendering the insulating materials of electrical conductors incombustible. The asbestos used in this paint comes from the Italian mines in the vicinity of Turin, over which the company have a monopoly. Italian asbestos, unlike Canadian, is long, fibrous, and strong. It is a silicate of magnesia, containing a small percentage of alumina and lime. The supply is said to be practically inexhaustible.

THE ELECTRIC LIGHT IN INDIA.—Poona is stated to be bestirring itself in the matter of the electric light. Major Ducat has almost completed arrangements with the Eastern Electric Light Company to light the cantonment with some forty arc lights placed on lamp-posts forty feet high. Incandescent lamps will also be introduced. The immense water-power now going to waste at the Bund will be utilised to work the dynamo machines, so that the cost of the illumination ought not to be heavy. The town of Ahmedabad is also in treaty with the same company, and a pretty extensive system of lighting will be established there. Broach will also avail itself of the electric light. In Bombay there seems to be every probability that the Marine Lines, now so obscure when the sun is down and the moon is not up, will be lighted by a combination of arc and incandescent lamps. A large number of private individuals are also anxious to employ the new light. Messrs. Treacher and Company's newly reconstructed premises are already lighted by electricity, supplied from the *Bombay Gazette* office on the opposite side of the boulevard called Rampart Row. Altogether the electric light is making its way in India.—*Homeward Mail.*

TELELOGUES AND TELEGRAMS.—In a note in No. 1 of this volume we quoted some facts with regard to the number of messages passing over the United Telephone Company's lines and those of the Post Office from a letter written to *The Times* by Mr. Batten. In the December *Journal* of the Statistical Society Mr. Batten gives some additional information on the subject, which is interesting. He says:—"When, in December last, I ventured to state to the Statistical Society that I thought the penny telelogue might be a fact by the end of 1881, though the members applauded, I think they were sceptical. . . . We have already reached this stage, and 20,000 messages a day are now being conveyed by telephone at a cost of only one penny each; but more than that, as I stated it would be, the telegraphic postal messages have also increased far more than in any previous year." Then follows a comparison between the business of the Telephone Company and the Post Office for October and November, 1881, from which we make the following extracts:—Post Office, total messages per day, 35,000; Telephone Company, 19,500. P.O., estimated number of words, 20, = 700,000; T.C., estimated number of words, 100, = 1,950,000. P.O., cost of messages to public, £1,750; T.C., £81. P.O., cost per message to the public, 1s.; T.C., 1·08d. P.O., messages in 1880, 9,854,566, or 27,001 per day. P.O., estimated messages in 1881, 12,835,000; T.C., allowing present rate only of increase, 10,950,000. P.O., cost to public, £641,750; T.C., £42,000.

ELECTRICITY AND THE ELECTRIC TELEGRAPH.—This was the subject of a lecture delivered at Kensington, on Monday evening, by Mr. Robert W. Johnston, Postmaster of the Eastern Central or "City" district. He brought forward some interesting statistics of the progress made by telegraphy in recent years, and alluded to the time when the charge for a message from Edinburgh to London was something like 12s. 6d., whereas now it was possible to telegraph from Scilly to Shetland, or from Jersey to John o' Groat's for 1s. Fifty thousand miles of wire in 1870 had increased to considerably more than 100,000 in 1882; 2,200 instruments worked by all the companies had increased to nearly 9,000 worked by the Post Office; and 2,500 telegraph offices under the old *régime* had increased to more than 5,500 under the new. Four thousand persons of all classes employed by the companies had increased to nearly 12,000 employed by the Post Office, and of these about 1,600 were women, of whom 600 are employed in the Central Telegraph Office alone. As to the transmission of news for the Press, the Post Office had converted into an attractive monopoly what used to be a rather repulsive combination on the part of the old telegraph companies, and on one occasion quite recently as many as 700,000 words, equal to 350 average columns, had been transmitted from the central office alone. The lecture was illustrated by specimens of most of the instruments in use by the Post Office, as well as by a working model of the pneumatic tube system, telephones in circuit, and some minor experiments with the electric light, conducted by Mr. H. Eaton, telegraph engineer, and Mr. Cooper, of the Post Office electrical staff. Mr. Mason, of the special arrangement staff, also assisted.

MERCADIER'S SELENIUM CELL.—*La Nature* gives the following description of how M. Mercadier constructs his selenium cell. Two strips of brass are taken, about one-tenth of a millimetre thick and one centimetre wide. These are separated by two strips of parchment, and the four strips, or ribbons, are rolled up in a spiral form, so that we have alternately brass and parchment. This spiral is then placed between two sheets of brass, which press it together, one sheet being connected with the end of one brass strip and the other sheet with the end of the other strip. The whole is then tightly fixed between two pieces of wood, which press on each of the sheets of brass, the pieces of wood being bound together by screws running through their ends, the whole forming a parallelogram of which the screws are the shortest sides. Two terminals connected with the two brass sheets serve to join the cell up to any circuit. The whole cell then presents a surface of about $1\frac{1}{8}$ inch by $2\frac{7}{8}$ inches. One surface is then filed and polished with emery paper. Having polished it, and ascertained by means of a sensitive galvanometer the absence of any metallic connections, the polished surface is covered with selenium in the following manner:—The cell is warmed by being placed on a thick plate of copper heated by a Bunsen burner just at the moment when a pencil of selenium above it is at the point of melting. The pencil is caused to traverse the surface of the cell so as to cover it with as thin a coating as possible. By not permitting the temperature to range higher than this point, the selenium takes the slate-coloured tint, which is its characteristic when most sensitive to light. When cold the cell is ready for use. To preserve the surface it may be protected by a thin sheet of mica. If the cell begins to lose power it should again be filed, repolished, and covered with selenium

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CRYSTAL PALACE EXHIBITION.

One interesting feature about this Exhibition is that it points steadily to progress. Although the Paris Exhibition has but lately closed, and was thought to contain all the novelties of the day, new and improved instruments are to be seen at the Crystal Palace. The nine days' wonder at telephony has, perhaps, given place to a ninety days' wonder at the electric light, but the part telephony is destined to play in the history of civilisation is so vast that whatever concerns its development must be important:—

> Seems it not a fear sublime,
> Intellect hath conquered time;
> Sing who will of Orpheus' lyre,
> Ours the wonder working wire.

Bell, Edison, Hughes, have given us instruments so simple, so complete, so useful that the more they are studied the more wonderful they become. These instruments, however, although transmitting or receiving duplex sounds, have hitherto necessitated a special wire for each pair of instruments. The introduction of exchanges has, to a certain extent limited the length of line wire, but it has been the special aim of Messrs. Brown and Saunders to devise an instrument that shall permit of one line wire only being required for several subscribers. The instruments are shown at the end of the Eastern Telegraph Company's stand.

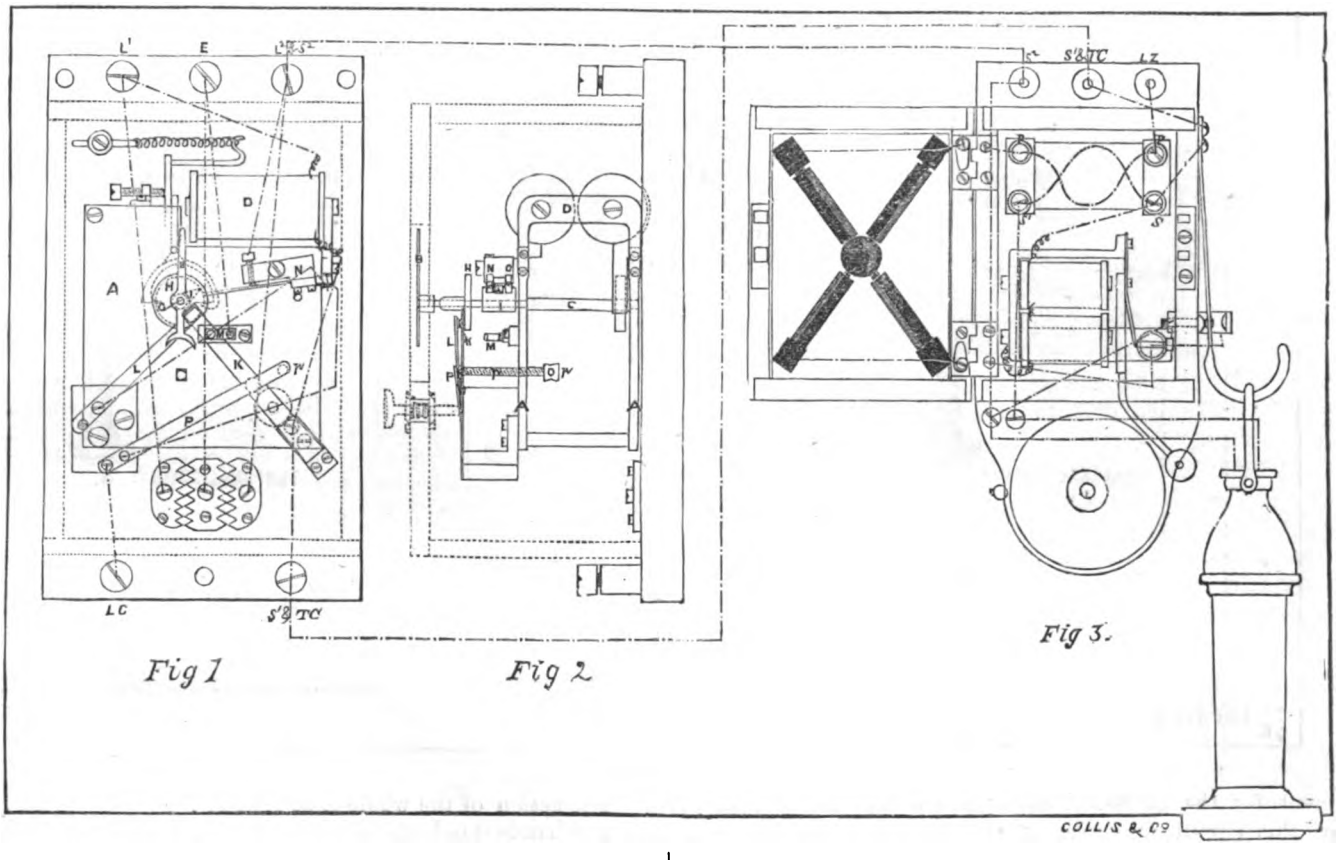

Fig 1 Fig 2 Fig 3.

Brown and Saunders' Telephonic Signalling Apparatus.—Before describing the details of the apparatus, it may be well to say more about its uses. The apparatus allows a number of telephonic or telegraphic stations in series on one line, in such a manner that, the line being disengaged, any subscriber can take possession of the line and call or speak to any other subscriber without disturbing the remainder, and in absolute secresy so far as the other subscribers except the one spoken to are concerned. Each instrument shows the number of the receiving subscriber, and is thus a guard against any one detaining the line too long. A bell also is used to ring, so as to remind the caller to clear to line when his communication is finished. It seems to us, being somewhat inclined to investigate mathematically, that the instrument will be found far more generally useful than the inventors seem to think. They point out its great use on suburban lines in connection with a central exchange, and on lines where the work is not heavy, to connect the houses of firms doing business together, or the various departments of a large factory, in small villages, and so on; but we imagine that the large exchanges will find it useful in their ordinary work. Suppose A to be a subscriber to the central exchange, and that it is found his wire is used 10 minutes during a day of 10 working hours, or 600 working minutes—*i.e.*, it is used 1 minute in 60, or it is 60 to 1 that the line is in use at any particular minute, hence little difficulty would arise if two or three, or four, subscribers were put on that wire with requirements similar to those of A.

The apparatus for one station consists of the transmitter, the receiver, and a battery for locally ringing the bell. Fig. 4 shows the external forms of the instruments at the terminal and intermediate stations. The current for the signals is obtained from two opposed batteries, placed one at each terminal station. The batteries being similar, no work is done by them except during the action of calling.

The signal instrument consists of a clockwork movement, A (Figs. 1 and 2), controlled by an electro-magnet, D, and actuating a main arbor or axle, C. This axle carries a hand, B, to indicate the numbers on the dial of the respective subscribers; also a slotted disc, H, and a cam, I. Metallically attached to the main framework is a ringing spring, K, which extends over the slotted disc H, and under nominal conditions makes contact with another spring, L, which is attached to the main framework by a piece of ebonite. Affixed also to the main framework by the same piece of ebonite is another spring, P, which rests on the top of spring K, but is insulated therefrom by an ivory stud. This spring P when spring K is pressed falls upon and makes contact with a screw stud, *p*, screwed through the top of the main framework, but otherwise held out of contact therewith by spring K. When the hand B comes round to the number or signal belonging to the station in which that particular instrument is placed, the cam I comes into contact with and slightly lifts the ends of two springs, N and O, attached by a piece of ebonite to the main framework, as shown, and in so doing breaks the contact of N with a screw stud with

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which it normally makes contact when not so lifted by the cam.

The connections are then as follow:—A wire leads from the Line 1 (marked L^1) or upper left hand terminal of the signal (looking at it from the front) to the electro-magnet D, the other side of this coil being attached to the main framework. The current then goes by the terminal marked S^1 and T C, being the lower right hand terminal, and the similarly lettered or centre terminal on the switch Bell transmitter, Fig. 3, to one side of the secondary coil of the induction coil, calling on its way at the top (or centre of motion) of the switch hook as shown. From thence the current goes on through the secondary and telephone or telephones (if more than one be used they should be joined in quantity or multiple arc, so as to diminish instead of increase their combined resistance) to the under stud of the switch-hook, or to that stud with which the hook makes contact when the telephone is hanging thereon, and thence on to the terminal marked S^2, being the left hand terminal of the switch bell transmitter, and thence on by the short external bridge wire between the two instruments to line.

There is thus always a complete circuit through the instrument for the current by the parts above named. The part of this circuit consisting of the telephone and secondary, however, is normally kept short circuited by two distinct methods, as follow:—One of these shunt circuits starts from the clock frame by the spring K, which is normally in contact with spring L, and thence goes on to spring N, which is normally in contact with its screw stud; from which a wire leads to the terminal marked line 2 or L^2, being the upper right hand terminal of the signal, which is also the terminal to which the wire from the other end of the secondary and telephone is joined.

The other short circuit is through the switch hook, as will be seen (when the telephone is hanging thereon); but this short circuit is, of course, broken when the telephone is taken off the hook.

This completes the set of connections for the line circuit.

For the local circuit a wire is then run from the copper pole of the local cell or cells to the terminal L C, being the lower left hand terminal of the signal. From here a wire leads on to the lower cross spring P, and also to the lower spring O of the pair of springs N O. It will be seen that at both of these points local copper is capable of being put into contact with the main framework, either by hand (by pressing spring K, and so dropping spring P on to its contact stud *p* in the frame) or automatically by bringing cam I into contact with spring O.

In either case the local current having been put on to the main framework will traverse the following circuit:—

First it passes out of the signal instrument by the terminal S^1 and T C and the outside connecting wire to the similarly lettered terminal on the switch bell transmitter along with the line current, with which, however, it makes no contact, in consequence of there being no connection whatever with the other pole of the local battery except by its own wire. From the top or centre of motion of the switch hook, to which this terminal is connected, the local current then goes on through the bell coils to the upper stud of the switch hook (or that stud with which the hook is in contact when the telephone is removed therefrom), so that when this is the case the bell is short circuited. From this point the current goes by the transmitter and primary coil of the induction coil to the terminal L Z, being the right hand terminal of the switch bell transmitter, from which a lead is run back to the zinc pole of the local bell or bells, thus completing the local circuit.

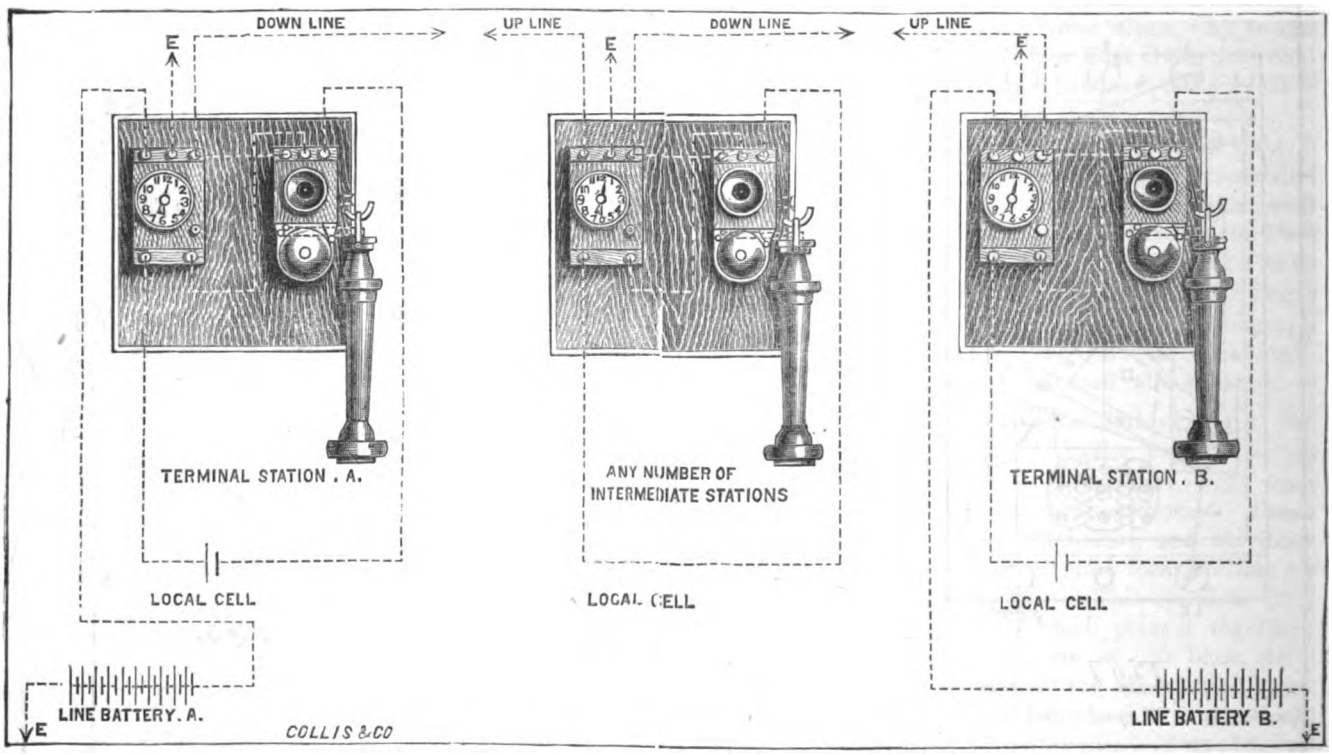

Fig. 4.

The action of the whole is as follows:—

The hands standing at zero (indicating that the line is disengaged) any subscriber can call by pressing his ringing plunger. The spring K will then be pressed through the slot in the disc on to a stud M, which is in electrical connection with the earth terminal E or upper central terminal of the signal (the slot in the disc H being then—and then only—in position to allow of this taking place).

This puts an intermediate earth on the line, and so brings the opposed line batteries into effective action; the one battery working all the instruments on the one side of the caller, including his own instrument, and the other battery working all the instruments on the other side of the caller, the effect of the current being to draw up the armatures of all the electro-magnets D, and so cause the clocks to advance one half step. By then letting his plunger come back, and so breaking the contact of spring K with the earth stud M, the armatures will be again let go, and the clocks will advance another half step. By then alternately pressing and releasing the plunger the subscriber can bring the hands round to the number he wants, and there stop. The cam I in the instrument belonging to that number will then be in contact with spring O, thus ringing his bell, and will also,

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by breaking the contact of spring N with its contact stud, break the short circuit through the signal of the telephone and secondary, thus placing him in effective speaking condition. It is then his duty to answer by taking off his telephone and calling "Yes" through the transmitter, the act of taking off his telephone automatically removing the remaining short circuit thereof and at the same time short-circuiting the bell, thereby stopping its sounding and concentrating the local current on to the transmitter.

The same effect is also produced by the calling subscriber taking off his telephone previous to listening for receiver to reply by so calling "Yes."

It will be seen that the short circuit through the signal of caller's speaking instruments (or telephone and secondary) was automatically broken by him in calling by the breaking of the contact of springs K and L, in consequence of the former passing under the insulating disc H at the first stroke of the plunger, from which position it cannot emerge until the disc again comes round to its zero position, that is, when the caller clears the line.

He also automatically puts the local current on to his bell and transmitter, by the dropping of spring P on to its contact stud *p*, in the clock frame. The current is, however, as before, concentrated on to the transmitter while they are speaking, in consequence of the bell being short circuited by the switch hook; but this short circuit is again broken when the telephone is hung up, and the bell, therefore, then commences to ring, and thereby gives him an unmistakable signal to clear the line, in case he should neglect to do so. This he does by again pressing his plunger in and out until the hand comes round to zero, when spring K comes up through the slot in the disc H, makes contact with spring L, and, at the same time, lifts spring P out of contact with its stud *p*, thus breaking his local circuit and stopping his bell, and rendering the line available for any other subscriber who may wish to use it.

It will be seen, however, that while the line is so engaged by one subscriber, the slots in the discs of all the other instruments are out of position for allowing the springs K to pass through, so that these subscribers cannot ring until the line is cleared by the caller; neither can they break the short circuit through the signal of their speaking instruments, in consequence of spring L following up and remaining in contact with spring K right up to the surface of the disc H, through which K cannot pass; and the cam I is then out of position to break the short circuit by lifting spring N, except at the instrument at which the caller stops—that is, the one he wants to call.

The vibrating bells are retarded a little by letting out their adjusting screws, so that the hammers require to make three or four vibrations before striking the bells, in order that the latter may not be sounded, or at most not sounded more than a very few strokes, by the momentary completion of the local circuit as the cams in the instruments down the line successively pass their contact springs, but only be sounded continuously in that instrument at whose number or signal the caller allows the hands to stop or remain—that is, the one he wants to call.

The connections necessary for the installation of this instrument are very simple. With an intermediate station the Cu pole of the local cell is connected to the terminal L C and the Zn pole to L Z. The earth terminal is connected to the binding screw E. The line wires are connected to L^1 and to L^2 S^2 respectively. The line connections at the terminal stations are a little different, one at each station being connected to the Zn pole of the line battery, whilst the Cu pole is put to earth.

Electric Lighting in 1848.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. D. H. Shedoker communicated an extract which he had made from an old paper, describing an exhibition of the electric light in Trafalgar-square (London) in 1848. The writer of the description expressed a belief that he would shortly hear of the "total extinction of half of the gas companies in the kingdom." But in those days the gas engine was not dreamt of.

CORRESPONDENCE.

SOFT IRON FOR ELECTRO-MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I shall be obliged if you will allow me to ask through your columns whether the very soft malleable cast iron will form as efficient a soft iron core for an electro-magnet as soft wrought iron, and also to what extent ordinary soft cast iron is inferior to wrought iron for this purpose. Cast iron is used in one or two dynamo electric machines which you have illustrated in your pages, but I want to know if malleable cast iron or simple cast iron will do for small magnets.—Yours, &c.,

Ybrow.

London, 14th February, 1882.

THE BEST POSITION FOR CARBONS IN THE ARC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Urquhart, in his "Electric Light," says:—"A horizontal arc does not give so much light as a vertical one."

Can he or any other correspondent give further particulars as to this curious fact, with the reasons for it? And does an arc in a diagonal line, as in Mr. Urquhart's own lamp, give as much light as a vertical arc?—Yours, &c.,

London, Feb. 4, 1882. G. R. N.

SUBMARINE CABLES.

The various cable companies have addressed to the Board of Trade, through Mr. Pender, M.P., a letter in which they suggest the enactment of the following provisions for the protection of submarine cables:—

1. That submarine cables should be entitled to protection against negligent or intentional injury wherever occasioned, and that the damages recovered should be exemplary whenever the injury done should be unnecessary and wilful.

2. That vessels should be directed not to anchor within—say, one mile of the line of a submarine cable as laid down by the charts, unless in case of necessity, caused by stress of weather or other sufficient cause, and that in the event of ships so anchoring and fouling the cables, stringent precautions should be observed in recovering the anchor.

3. That the companies should be bound to make good the loss of anchors, chains, and other gear when *bona fide* sacrificed to prevent damage to telegraph cables.

4. That vessels and fishing boats should be compelled to keep clear of steamers and buoys employed in laying and repairing submarine cables.

5. That in respect of the use of trawls improperly repaired and unduly dangerous to cables, a right of inspecting trawls and of requiring that they should not have projecting and ragged pieces should be vested in the Customs, or coastguard, or other local authorities. The mere fact that Government had established such an inspection would, in the belief of the companies, greatly diminish the number of injuries of this character.

6. That trawlers should be directed to act with caution while dragging across ground where cables are known to lie, and that in case of fouling the cables the same regulation should be observed as above suggested in case of anchoring and fouling.

7. That all vessels and fishing craft should be liable in damages wherever negligent or intentional injury to submarine cables, telegraph buoys, and other laying or repairing gear can be proved against them.

8. The companies might be required to publish in a sufficient manner, by notices at all custom houses, coastguard stations, or other centres of nautical and fishing resort, particulars of the course and direction of their cables, and to afford to the hydrographical offices the same information, to be embodied in their charts.

9. An additional clause would provide for the exclusive jurisdiction of the Admiralty Courts.

The mere enactment of such protective laws would, the companies believe, prove a substantial check upon the ruthless indifference with which submarine cable property is at present treated. They disclaim any intention to restrict the freedom of anchorage in any case where the safety of the vessel might be imperilled. All they desire is the prevention of negligent anchorage in the vicinity of cables in cases where such anchorage is in no way essential; and no actual prohibition is sought even in this respect.

The companies would not object to incurring the responsibility of compensating vessels for the loss of cables or anchors which might be abandoned in order to avoid the cutting of telegraph cable.

The furnishing of evidence as to the destruction of cables appears to the companies "not to offer the difficulties which the Board of Trade seem to consider almost insuperable. One of the first measures adopted by the companies would doubtless be the offer of a liberal reward for information, and it is contrary to all received experience that this would fail of effect. The possibility of information being furnished would of itself act as a powerful deterrent, and one or two cases of recovery of damages would operate still more decidedly in the same direction."

The companies express their regret that the Board of Trade have yet seen no reason for exempting vessels actually engaged in cable-laying and cable-repairing from the payment of light and harbour dues paid by other vessels. Their vessels are not unfrequently in and out of harbour half a dozen times or more before the repairs are effected, especially when in proximity to the coast of England and Europe; and in many cases are repeatedly driven into these harbours by stress of weather, and thus compelled to incur a repetition of the charges for light and harbour dues.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, *Strand, London, W.C.*

We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.

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NOTICE.—OUR SUPPLEMENT.

The supplement containing "Hints to Electric Light Engineers," published with our issue of the 7th January, can now be had at the office in pamphlet form, price one penny. In reply to several of our friends we may say that our next Supplement is in active preparation, and we hope to be able to issue it shortly.

AT THE CRYSTAL PALACE.

It is with much satisfaction we are able to announce that the Exhibition arrangements at the Crystal Palace are now approaching completion, and that in respect to the electric lighting of the edifice the public may visit it without risk of being disappointed. The circumstance that no definite date was fixed for a formal opening seems to have acted upon the exhibitors as a kind of permit to delay their contributions as long as they pleased. Added to this, there is the perhaps more satisfactory explanation that pressing demands from the outside public are taxing the resources of the several firms to the utmost. Thus the long reach of benches week after week has continued to be decorated only with the names of the intending exhibitors. At length, however, there are signs of awakening energy, apparatus is arriving in plenty, the stalls begin to present the appearance of being furnished, and by the time these lines are in print it is hoped that the show will be worthy of public inspection.

This has been the case in respect to the electric lighting portion of the Exhibition for some time past, a sufficient number of installations having been completed to well repay the evening visitor. Cheap trains, we are informed, are being run to the Exhibition from the provinces; and now, indeed, is the time for people who return home the same day to avail themselves of the comparatively long evenings for the purpose of witnessing the performance of the several systems of electric illumination, and comparing them one with another. Such an opportunity is not likely to occur again, and intending users are afforded the best of all means of making their choice before they enter into any contract. That there are plenty of systems to choose from cannot be denied. Their adaptability to every possible requirement can hardly be doubted. And, lastly, in such a competitive market the conditions are all in favour of the buyer.

To the sight-seer, also, the spectacle is one that should not be missed. The mere lighting of such a place as the Crystal Palace by means of electricity is of itself something worth seeing; and the variety in the character of the lights lends an additional interest to the scene. But over and above all this the exhibitors have done their utmost to make their wares beautiful as well as useful. At the Paris Exhibition only in a few instances was an attempt made to step much beyond the bare requirements of utility. In the interval great pains have been bestowed on the designs of the lamps and their fittings, and we have now a display of ornamental art sufficient to gratify the taste of the most æsthetic. Just outside the Tropical Department, for example, the Weston arc lamp, and various forms of Maxim incandescent lamps, exhibited by the Electric Light and Power Generator Company, make a most attractive show, the Maxim lamps in particular within their opalescent bells, artistically grouped, presenting a very pleasing picture. In exclusive possession of the Tropical Department is the Lane Fox lamp, differing from its rivals in the colour of its rays. Between the central transept, where Mr. Crompton's lamps attract many admirers, and the Maxim lamps above mentioned, there are a number of magnificent Brockie lamps; and on the other side of the transept is the Mackenzie lamp, exhibited by Messrs. Strode. The Handel Orchestra is lighted by the Pilsen arc lamp, which was shown before the members of the Society of Telegraph Engineers last week. Inside the concert room and entertainment court Mr. Edison has equalled if not exceeded his rivals in artistic workmanship. There the chandelier is in the form of a bouquet of flowers, and is of coloured glass, an electrical lamp nestling in every flower. The Swan lamp, now too familiar to require special description, is to be seen in several parts of the building, forming part of the Siemens exhibit, as well as affording ample light in the picture galleries. Over the fountains, and at what is called the clock end of the Palace, there is a splendid candelabra—if we may be permitted so to call it—erected by Messrs. Siemens, and this is undoubtedly one of the sights of the Exhibition. Here and there are dotted Jablochkoff lamps and other systems not so well known, but all lending the charms of novelty and variety to a singularly fascinating display. Lastly, the otherwise dreary, and, we may add, always weary arcades by which the Palace is approached from the Railway, are being agreeably lighted by the Brush system.

Underneath are the benches on which the electrical apparatus are now being rapidly put into position. Foremost amongst these, as we have already noticed with satisfaction, are the exhibits from two Government departments, the War and the Postal Telegraph. Both these have completed their arrangements some time ago, and both are in charge of persons competent to describe the apparatus to curious inquirers. These good examples, we hope, will be followed by the other exhibitors. But be this as it may, the Exhibition, so soon as it is fully completed, cannot fail to be a most entertaining and instructive one. That it will repay the outlay on the part of exhibitors cannot be doubted if only they will hasten to avail themselves of the opportunity; and, having regard to the ample and very liberal accommodation afforded by the Crystal Palace proprietors, we hope, too, that they will be adequately rewarded by public patronage.

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VERITY AND SONS' ELECTROLIER.

The exhibitors of incandescent lights are showing that the electric light lends itself as well, if not better than gas, to elaborate and highly æsthetical designs in central and other lustres. One of the sights of the Crystal Palace Exhibition will be the electrolier in the Entertainment Court, which is now complete. This magnificent piece of work has been specially designed and carried out by Messrs. Verity and Sons, of King-street, Covent Garden, for Mr. E. A. Johnson, of the Edison Electric Light Company. We do not plead guilty to the introduction of a new word into the language—it is, so far as we know, due to Messrs. Verity and Sons; but if "chandelier" why not "electrolier?" Whatever it be called, the name will not detract from its beauty. As will be seen from the illustration, it represents a huge basket of flowers of various kinds, sunflowers, narcissus, tiger lilies, orchids, &c., all in hammered brass. It is 15ft. high and

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9ft. wide. Some 350 flowers are here represented in brass. The whole consists of several thousand pieces, the stems of the flowers of course being hollow to admit the wires of the lamps. The Edison lamps, 99 in number, are placed within the coloured glass lily cups, &c., and are on three circuits, either of which can be turned on or off at will. Poetry alone seems capable of giving adequate idea of this centre of attraction:—

Yes, so lovely is this place,
That the sun that flames refulgent
Would his own bright sphere abandon
For the fairer flower sphere under;
And the heavens, the flowers beholding
Radiant in their rosy clusters,
Would paint red their own pale stars
That with these they might be numbered.
Thus it is from evening's grey
To the morn's glad gleams of umber,
These cerulean stars appear,
Twinkling each with trembling lustre.

—*Calderon.*

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

IX.

Measurement of Current in Absolute Measure.

The unit of current has been already defined, and it only remains to explain the definition a little more fully, and to show how any current can be practically measured.

The definition of the unit strength of current is implicitly contained in any of our equations in which γ occurs; but the most convenient of these is that which expresses the intensity of magnetic force at a point on the axis of a circular coil.

To obtain this, remember that, at a point from which a circuit subtends a solid angle ω, the potential is $\gamma\,\omega$ (Art. VI.), and the force, in the direction dx, is $\gamma\frac{d\,\omega}{dx}$. Now a circular ring of radius y subtends, at a point on its axis at a distance x, the solid angle

$$2\,\pi\,(1-\cos\theta) = 2\,\pi\left(1-\frac{x}{\sqrt{(x^2+y^2)}}\right),$$

whence the value $\frac{d\,\omega}{dx}$ is seen to be

$$\frac{2\,\pi\,y^2}{\left\{x^2+y^2\right\}^{\frac{3}{2}}}.$$

For the special case when x is nothing—that is, when the point is at the centre of the ring, this becomes simply

$$\frac{2\,\pi}{y}.$$

The intensity of the field, due to a current in the ring, is therefore known, and is the same as that which we obtained last week by the Ampèrian method.

If the ring were wound with n turns of wire, instead of with one, the magnetic force at its centre would be

$$\mathrm{I} = \frac{2\,\pi\,n\,\gamma}{y}.$$

To obtain a magnetic measure of a current, then, it is sufficient to send it round a circular coil of wire, and to determine experimentally the force which a unit pole experiences when placed at the centre, or on the axis, of the coil.

In order to make this determination, the simplest plan is not to attempt to put a single pole at the selected point alone, but to place a whole, very short, magnetic needle there; so short compared with the size of the ring that both its poles may be regarded without sensible error as being at its centre.

As soon as the current to be measured is sent round the ring the needle will experience a deflecting couple, and it is this couple which we must proceed to measure.

This couple, of course, depends on the magnetic moment of the needle and on its position with reference to the plane of the coil, as well as on the intensity of field I in which it is placed. Calling, therefore, the moment of the needle M, and the angle it makes with the plane of the coil θ, the couple it experiences is (see Art. II.)

$$\mathrm{I\,M}\cos\theta;$$

which in the present case has the value

$$\frac{2\,\pi\,n\,\gamma}{y}\,.\,\mathrm{M}\cos\theta;$$

and if there is no other force acting on the needle, it will at once set itself so that $\theta = 90°$, *i.e.*, will point along the axis of the ring.

This tendency we must now proceed to oppose by some measurable force. One plan would be to suspend the needle by a torsion fibre, and to determine the angle of torsion necessary to bring the needle back into some selected initial position; the terrestrial magnetic meridian being naturally chosen for this initial position, in order to avoid complication arising from the action of the earth on the needle in addition to the action of the torsion fibre.

The defect of this plan, however, would be that the couple so determined would involve an unknown and uncertain quantity, M, a quantity which it is troublesome to determine and which is liable to capricious alteration.

Hence this plan is never adopted, but the earth's magnetism is always made use of to oppose the deflecting couple of the current.

The effective moment of the earth on an ordinarily balanced compass needle when it makes an angle θ' with the magnetic meridian is, we know, $\mathrm{M\,H}\sin\theta'$; and if we place the ring round the needle so that its plane is in the magnetic meridian, we shall have the two angles, θ and θ', the same.

In this state of things the earth's couple, $\mathrm{M\,H}\sin\theta$, is tending to restore the needle to the meridian, or to make $\theta = 0$; the coil's couple, $\mathrm{M\,I}\cos\theta$, is tending to deflect the needle away from the meridian, or to make $\theta = 90°$.

For some value of θ, therefore, which we will call ϕ, these two couples must exactly balance, and the needle will settle down after a few oscillations into this position, making the angle ϕ both with the plane of the meridian and with the plane of the coil, an angle which it is easy to observe and measure: and we have in this position the equation between the two opposing couples

$$\frac{2\,\pi\,n\,\gamma}{y}\,\mathrm{M}\cos\phi = \mathrm{M\,H}\sin\phi; \quad . \ . \ . \quad (1)$$

and from this equation the unknown quantity M conveniently disappears, leaving us

$$\gamma = \frac{y\,\mathrm{H}}{2\,\pi\,n}\tan\phi.$$

Now, H, the value of the earth's horizontal intensity at a given time and place, is a thing which may be supposed known, if there are no masses of iron in the neighbourhood. For London it is now ·18, and it changes but slowly. The radius of the coil, y, is a thing easily measured with more or less accuracy, and the angle ϕ can be observed. These being all known the value of γ can be expressed numerically; and, as its expression depends on no local or adventitious circumstances, it is said to be expressed in *absolute measure*. Since its expression depends on that of the unit magnetic pole, and is obtained by an electro-magnetic experiment, it is said to be expressed in absolute *electro-magnetic* measure.

The above is the theory of the single-ring tangent galvanometer; but the field at the centre of a single ring is not extremely uniform, and it is essential for accuracy that the field should be uniform, because we have supposed both poles of the needle to be in a field whose strength is the same as that at the centre of the coil. The complete investigation, taking account of the actual intensity of field at each pole of the needle whatever its deflection, can be made, but it is very complicated, and not very satisfactory, because the poles of a needle are not very definite points.

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It has been shown, however, that the field of force due to two equal circular coils, both carrying currents in the same direction, is extremely uniform in the middle of the region between them; especially if the distance between the coils is equal to the radius of either.*

Place such a pair of equal coils, then, in the magnetic meridian, and suspend a needle at the middle point between them, and we have the more accurate tangent galvanometer of Helmholtz.

The distance of the needle from the plane of either coil call x, and the radius of each coil y, as before, then the intensity of the field due to the two coils, if each has n turns of wire, is simply

$$\frac{4\pi n\gamma y^2}{(x^2+y^2)^{\frac{3}{2}}};$$

and the preceding investigation of the single ring instrument remains unaltered, except that in equation (1) the constant $\frac{2\pi n}{g}$ has to be replaced by the constant

$$\frac{4\pi n y^2}{(x^2+y^2)^{\frac{3}{2}}}.$$

In the important special case when $y = 2x$, *i.e.*, when the distance between the coils is equal to the radius of either, the constant becomes

$$\frac{32\pi n}{\sqrt{125}\cdot y}.$$

This constant, whatever its value (and its value can easily be ascertained by measuring the galvanometer, or it can be recorded by the maker) is called "the galvanometer constant," and we will denote it, for shortness, by G. It may be defined very simply as the intensity of field produced at the needle's position by unit current circulating in the coils.

Using this symbol G, whose value in all the more important cases occurring in practice has been now recorded,† the equation for determining the strength of the current may be written

$$\gamma = \frac{H}{G}\tan\phi. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This is about as general as it is necessary for most practical purposes to go, but it is instructive, entertaining, and quite easy, to take a still more general case at once *de novo*.

General Theory of a Galvanometer.

Let a galvanometer be made of any number of separate coils of any shape, and arranged in any positions you like.

Choose a point wherever the field they produce is tolerably uniform, and where their resultant lines of force are at right angles to the magnetic meridian.

Let the sum of all the solid angles subtended by them all at this point be called ω, and send a current of strength γ round them all.

Then the potential at the point is $\gamma\omega$, and the force perpendicular to the meridian is $\gamma\frac{d\omega}{dx}$.

This quantity $\frac{d\omega}{dx}$ is the galvanometer constant G, and the intensity of the force is simply $G\gamma$.

Balance this against the earth's horizontal force by letting them both act on a compass needle placed at the point and deflected by their joint action through an angle ϕ, then the ratio

$$G\gamma : H = \tan\phi.$$

Few things can be much more simple than that.

* In this position each coil subtends at the needle a solid angle equal to π. (See end of Art. VI.)

† For the single-ring tangent galvanometer of radius y,

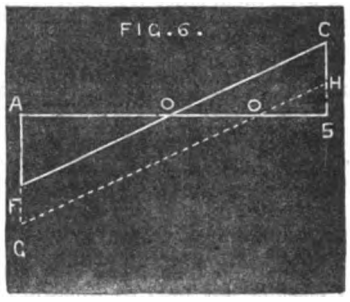
$$G = \frac{2\pi}{y}.$$

THE (ELECTRIC) CONDUCTIVE AND INDUCTIVE CIRCUITS GEOMETRICALLY ILLUSTRATED.

BY F. C. WEBB, M.I.C.E.

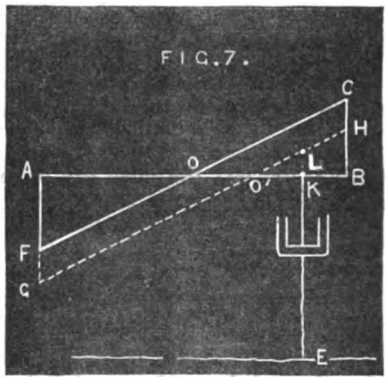
(*Continued from p.* 135.)

If the circuit is insulated entirely from surrounding objects, and unelectrified from any external source, then, as we have before seen, in a circuit of homogeneous material of equal section throughout, and every part of the circuit similarly situated throughout in regard to the nearest conducting surface (as is, in fact, the case in a submerged submarine cable), then the point of no potential, O, will be equivalent from the surface of generation, and if we touch the point O to the surrounding conducting surface, or to earth, no effect will be produced on the position of the line of potential, and we have seen that if the point A be touched to earth, the line of tension is altered, and the diagram becomes as shown in Fig. 5. If any other point, such as O′ (Fig. 6), be



touched, that point will become the point of no potential, the potential at B will drop to H, showing a drop from a positive potential (equal to half the electromotive force of the circuit) to one of a less positive state, and an equal drop at B to a higher negative potential, the line of potential being shown by the dotted line G H.

The position of the line of potential can also be altered without absolutely touching the circuit to earth. For instance, if the circuit at any point, K (Fig. 7), be connected to the interior of a Leyden jar the outer armature of which is connected to earth, then the point O will move to some position O′ between O and K, and the potential at B becoming B H, at K L and at A, A C and the line of potential will become G H. The distance that the point of no potential will move towards K, and, consequently, the amount of drop down-



wards of the line of potential, will depend on the proportionate electrostatic capacity of the Leyden jar to electrostatic capacity of the whole circuit. If the capacity of the jar is equal to the whole electrostatic capacity of the circuit the potential at K will drop to exactly half, and its previous potential and the other potential at all points of the circuit will be altered in proportion, thus preserving parallelism between the new and old line of potential.

If the Leyden jar has an equal electrostatic capacity per unit of surface with that per unit of surface of the conductor forming the circuit, then the exact drop in the line of potential can be accurately calculated by a formula given by Ohm, which, expressed in simple language, would be as follows:—

Let r = the total surface of the conductor forming the circuit.

R = the surface of the jar.

U_1 = the potential at the point k before being touched to the interior of the jar.

U = the potential at the point k after being touched to the interior of the jar.

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Now, as we have supposed every unit of surface of the conductor forming the circuit and of the jar to have equal electrostatic capacity, it is evident that the quantity of electricity on any unit of space, however minute, will be proportional to the potential at that space; or, in other words, the *density* of the electricity at any point will be proportional to the potential at this point; consequently, the quantity of electricity in the jar after contact will be U R. And since the quantity lost by the circuit will be $(U_1 - U)\,r$, and since this quantity lost by the circuit is equal to that which the jar has received, we have

$$(U_1 - U)\,r = U\,R,$$

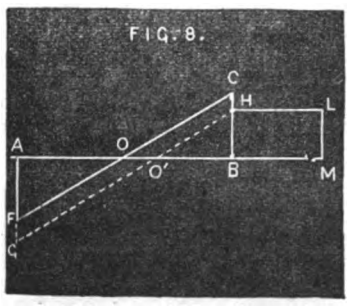
or

$$U = \frac{U_1\,r}{r + R}.$$

If we take for the conductor forming the circuit ordinary gutta percha covered wire, then, since its electrostatic capacity per unit of length is equal throughout, the quantity of electricity in any portion of it will be proportional to its length multiplied by the potential at every point, and if we use for our Leyden jar a length of similar gutta percha covered wire, then, since the *surfaces* over which the electricity is diffused in the circuit, and in the jar, will be proportional also to the *length* of the wires; consequently, for the surfaces represented in Ohm's formula by the symbols r and R we have only to state the *lengths* of wire in the circuit and the length representing the jar. And, again, as the density is proportional to potential, the lines representing the lengths multiplied by those representing the potential will be proportional to the quantity. It becomes, then, perfectly possible not only to illustrate the problem geometrically, but to solve it.

First let us illustrate the problem.

Let A B (Fig. 8) represent the length of circuit (to which its *surface* is proportional), and suppose a length B M of similar wire, insulated at its end M, be touched to the circuit at B (the point immediately on the positive side of the surface of generation), then,



when this length is touched, the effect will be to drop the potential at B by such an amount C H that C H × A B (viz., the quantity of electricity the circuit has lost) shall be equal to B H × B M (the quantity in the wire after being touched to the circuit at B).

And, in fact, we have the symbols in the formula thus represented geometrically:—

$r = A\,B =$

the total surface of the conductors forming the circuit.

$R = B\,M =$

the surface of wire representing the jar, or "body," as Ohm calls it.

$U_1 = B\,C =$

the potential at the point B *before* being touched to the wire R.

$U = B\,H =$

the potential at the point B *after* being touched to the wire R.

$(U_1 - U)\,r =$ the parallelogram F G C H $= C\,H \times A\,B =$ the quantity of electricity lost from the circuit and imparted to the wire R.

U R = the parallelogram B H L M or B M × L M = the quantity of electricity obtained by the wire R.

These last two quantities are equal. The construction and solution geometrically will follow.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The members of this society met on Thursday evening, February 9th, at the Institution of Civil Engineers, to witness an exhibition of the Pilsen Arc Electric Light, and to hear it explained by Mr. H. F. Joel, C.E., an associate of the society. There was a large attendance, and the hall was copiously lighted by six of the lamps in question suspended from the ceiling. These were supplied with current from a Shuckert machine, working at 850 revolutions per minute. The current was about 8·5 amperes, and the candle-power was estimated at 1,000 candles. In the course of the evening five of the lamps were extinguished, so that the amount of light given off by the single one remaining might be observed. There was, as is usual on such occasions, a few mishaps, one of the lamps in particular exhibiting on a small scale a decided aptitude for exactly imitating the panting and puffing of a steam engine—whether that of the one driving it nobody could say, but the performance excited much amusement and far more laughter than is common at such gatherings. It was explained, however, that the work of making the temporary arrangements for this lecture had only been commenced at six o'clock that evening, and of course they had to be done hurriedly, one lamp in particular having been inserted which was constructed for independent action, and therefore not suited to work with or to be worked in company with other lamps in series as these were. Notwithstanding all this, however, there was no actual collapse of the light such as happened on previous occasions of a like kind, and the light seemed to give general satisfaction, there being no unpleasant colour, unless indeed we have grown accustomed to what at first used to seem unpleasant; and although not perfectly steady there was no inconvenient alternations of brightness and gloom. Mr. Joel at great pains had illustrated his lecture with coloured drawings on a large scale which covered nearly one side of the Hall. The fact is worth mentioning, because it afforded a good test of the effect of electric light upon flat colour. The greens remained perfectly green, the blues blue, and all the rest as true, we believe, as in daylight. Flat colour we say; because it was noticeable that the oil paintings which decorate the upper recesses of this fine room, and which were lit up with unaccustomed brilliancy here and there by reason of the electric lamps being suspended high and without shades, were not improved by the nearness and searching character of the rays. Features and flesh tints seemed to be obliterated altogether, or exhibited only with that coarse unlikeness which is presented to us when looking at the human hand, for example, through a magnifying glass. Turning to the audience, pale people looked paler, and swarthy complexions were rendered not more lovely by the Pilsen lamp than by any other we have seen. On the other hand, those fortunate possessors of the hue which betokens plenty of fresh air may be thankful they lose none of its evidence under the rays of this or any other electric light.

The following is a brief abstract of the paper, which was read by the secretary, Mr. Joel supplementing it by a few explanatory remarks:—

The Pilsen Electric Light Arc Lamp is the invention of two Austrian engineers, Messrs. Pietto and Krizik, and is so called owing to the difficulty of correctly pronouncing the names of the inventors, Pilsen being the name of the town where the lamp was invented. The special and novel feature of this lamp is the use and action of a biconical or spindle-shaped iron core. When suspended between and partly through the interiors of two magnetic solenoids placed one above the other, through which an electrical current is passing when so used, such a core has no positive or balanced position (as in the case of the ordinary cylindrical core), and thus it has a very long extent of movement, which is utilised directly to feed the carbons in an electric light lamp, and so avoids the use of complicated mechanism, pendulums, &c., necessary when using the cylindrical core. The uniform action of this peculiar shaped iron core is due to the equal and opposite magnetic effect which appears as the result from the decrease of the mass of iron in one solenoid being compensated for by the increase of its magnetic action, and *vice versâ*, and it is this which constitutes the principal novelty in the Pilsen lamp.

The lamp consists principally of two magnetic solenoid coils of wire, one of thick wire in the main circuit, the other of thin wire of high resistance, in a shunt circuit with the double coned iron core freely suspended between them. These two coils are so regulated that, when the arc formed at the carbons is of exactly the proper length, usually two millimetres, the action of the coils upon the core is exactly balanced. Any alteration in the resistance of the circuits by increase of the length of the voltaic arc disturbs this balance, and the iron core with the top carbon attached descends and again restores the balance, and remakes the size of the arc of the predetermined length.

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This lamp is essentially an electrical lamp, as contrasted with mechanically regulated lamps, and, as made, is extremely simple, and entirely free from all clockwork or gear likely to get out of order. There are automatic appliances which render the lamp practically independent of all contingencies. When the carbons are all consumed the lamp is put out of action, and a branch circuit opened up for the main current to pass, and so keep the other lamps burning. Should the carbons be broken the same action takes place, and also without any carbon in at all the lamp can be kept in the main circuit. The arrangement for putting in fresh carbons is very simple, and the only mechanical work in the lamp is the counterbalancing the iron core.

Various lamps were described and illustrated, and details shown, amongst them the horizontal lamp, which is particularly simple, there being absolutely no mechanism whatever, even the counterbalance weight not being necessary. Another lamp suitable for factories was also described and illustrated. This has plate carbons and will burn thirty or more hours.

One of the advantages of this lamp is that it can be worked with almost any description of engine. The absence of all clutches and relieving gear enables the lamp to quickly adjust itself to variations of speed.

The Pilsen lamp has been fitted in many places and with unqualified success. It obtained a gold medal at the Paris Electrical Exhibition entirely and exclusively upon its merits. It is at present being exhibited in the Crystal Palace, where six hanging lamps illuminate the Handel orchestra, and also at Messrs. Wells and Co., Shoreditch. It has been pronounced by many qualified judges to be, without exception, the best electric light lamp yet brought out. The lamp is owned by Mr. James Fyfe, 52, Queen Victoria-street, E.C.

Mr. ALEX. SIEMENS being invited by the President to offer some observations on Mr. Joel's paper, had merely to say that, as the Siemens lamp had been referred to and contrasted with the Pilsen, he could only express his opinion that in the matter of mechanism there was not much to choose between them. The experience of his own firm was that sliding contacts (sliding adjustment gear was probably meant) were very liable to get out of order. Still, he was ready to admit that the invention was a very clever application of electrical laws to the purposes of electric arc lighting.

Professor AYRTON then informed the audience that while the paper was being read he had been testing the current, and had made some calculations, the result of which went to show that the total amount of current flowing through the whole six currents was about 12 amperes, and that the E.M.F. equalled 400 volts. For the single lamp, when the other five were extinguished, there was an E.M.F. of 75 volts, with an expenditure of about 1·2 horse-power.

The PRESIDENT (Lieut.-Colonel Webber), who had previously announced a gift to the society of a large portfolio containing photographs of exhibits, &c., at the late Paris Exhibition, presented by their French corresponding secretary, M. Aylmer, then closed the proceedings with a vote of thanks to Mr. Joel.

ON THE RELATIONSHIP BETWEEN THE E.M.F. OF A DANIELL CELL AND THE CHEMICAL AFFINITIES INVOLVED IN ITS ACTION.

BY C. R. ALDER WRIGHT, D.SC., F.R.S.

The results obtained by previous experimenters as to the absolute value of the E.M.F. of a Daniell cell differ somewhat widely, but are all approximately close to the value corresponding to the heat evolution in the reaction $Zn + Cu SO_4 = Cu + Zn SO_4$, as deduced from Julius Thomsen's experiments. It is known that the E.M.F. of a Daniell cell falls when a current is generated, the cell being in consequence said to be "polarised." The author has carefully examined into the various causes that bring about this fall, and the fluctuations observable in the maximum value of the E.M.F. according as the details of construction vary, with the following results :—

Firstly, the total amount of fall for gradually increasing current densities was investigated by means of cells containing two pairs of plates, one pair exposing double the area of the other, and the hinder surfaces of the plates being covered with gutta percha, so that only the opposed faces were in action. Each cell was arranged as a gravity battery, the two zinc plates, for instance, having their active surfaces in the same horizontal plane, and being immersed in strong zinc sulphate solution, on which floated a weaker copper sulphate solution, with two copper plates in the same horizontal plane, so that whether the large or small pair of plates were used the same compound column of fluid was between them, and hence the internal resistance, R, was the same. When the surface conditions of the larger and smaller pairs were the same, the difference of potential, E_1, set up with the smaller pair for a given current density, D (flow per square centimetre of plate surface) was necessarily $e - S_1 D R$, where e is the E.M.F. of the cell, and S_1 is the area of the smaller plate (2·5 square centimeres); whilst that set up with the larger plate, E_2, was $e - 2 S_1 D R$; whence $R = \frac{E_1 - E_2}{S_1 D} = \frac{E_1 - E_2}{2{\cdot}5 D}$.

By making two series of readings alternately with each pair of plates, and varying external resistances of the potential differences subsisting between the plates, the data were obtained for calculating by interpolation the potential differences E_1 and E_2 for various value of D, so that a series of value of R were deduced fairly concordant. Substituting the mean of these in the formulæ $e_1 = E_1 + S_1 D R$ and $e_2 = E_2 + 2 S_1 D R$, two series of values of the E.M.F.'s of the cell for different values of D were deduced, which agreed closely; the mean of these subtracted from the maximum E.M.F. (which was always found to be developed when no current passed), gave the amounts of fall for known increments of current density. By plotting densities as abscissæ and amounts of fall as ordinates curves were traced exhibiting the total diminutions in E.M.F. produced with different modifications of cell. It was found that but little difference was produced by using pure, commercial, or amalgamated zinc, or zinc-coated with a film of copper respectively; amalgamated copper plates gave more rapid rates of fall than electro-coated ones; and with dilute sulphuric acid surrounding the zinc the rate of fall was somewhat less rapid than with zinc sulphate solution. In all cases no appreciable fall was observed when the current density did not exceed 8 microamperes per square centimeter (corresponding with a cell exposing 500 square centimetres of surface to a current of ·004 ampere); with four to six times this density a diminution in the E.M.F. of from 0·5 to 1 per cent. was brought about; and with currents exceeding in density 3,000 microamperes per square centimetre (1·5 ampere with a cell of 500 square centimetres), the diminution exceeded 10 per cent.

Secondly, a long series of observations was made to find out the maximum E.M.F. capable of development with various kinds of cell when the solutions surrounding the metals are of the same specific gravity, the effects, thereupon, of differences in the specific gravity of these solutions, in order to see how far the above amounts of fall could be accounted for by the effects of the migration of the ions, causing a stronger solution of zinc sulphate to accumulate round the zinc plate, and a weaker one of copper sulphate round the copper plate, than were there previously.

The following table gives an epitome of the average results obtained as regards the first point, the zinc plates being surrounded by pure zinc sulphate solution.

Effect on the E.M.F. due to use of solutions varying in specific gravity, both the zinc sulphate and copper solutions being of equal specific gravity in any given case ..... Less than ± ·001.

	Maximum.	Minimum.	Range.	Average.
Effect of substituting for fresh electro copper :				
Bright rolled copper sheet..	+·010	+·001	·009	+·006
Amalgamated copper	+·002	−·003	·005	−·001
Effect of substituting for fresh electro zinc :				
Bright cast zinc	+·005	−·005	·010	+·001
Amalgamated zinc	+·003	−·004	·007	−·001
E.M.F. of combinations :				
Amalgamated zinc with amalgamated copper	1·109	1·104	·005	1·107
Ditto with electro ditto ...	1·110	1·105	·005	1·108
Ditto with bright ditto	1·118	1·109	·009	1·114
Electro zinc with amalgamated copper	1·110	1·104	·006	1·108
Ditto with electro copper ...	1·112	1·105	·007	1·109
Ditto with bright ditto	1·118	1·108	·010	1·115
Bright zinc with amalgamated copper	1·113	1·103	·010	1·109
Ditto with electric ditto.....	1·115	1·104	·011	1·100
Ditto with bright ditto	1·120	1·106	·014	1·116

These numbers represent the average values found during observation made within about four hours after setting up the

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cells. After longer periods, 24 to 48 hours, the maximum E.M.F. is notably diminished, partly by alteration of the surface of the zinc plates, partly by that of the copper, presumably by oxidation by dissolved air.

When dilute sulphuric acid is employed instead of zinc sulphate solution, the E.M.F. is raised to an extent the greater the stronger the acid (the $Cu SO_4$ solution being of the same density); thus with electro copper and amalgamated zinc the following average numbers were obtained instead of 1·108 volts as with zinc sulphate solution:—

Sp. gr. of fluids.	E.M.F. observed.	Calculated E.M.F.
1·010	1·123	$1·113 + x + y$
1·050	1·133	$1·124 + x + y$
1·090	1·142	$1·128 + x + y$
1·175	1·163	$1·141 + x + y$

When the two liquids surrounding the plates are not of the same specific gravity the E.M.F. is raised if the $Cu SO_4$ solution is stronger, and lowered if weaker, than the other by an amount which is variable with the precise values of the solutions, but which is sensibly the same as the E.M.F. developed when two solutions of copper sulphate in the one case, of zinc sulphate in the other, interdiffuse, their specific gravities being identical with those of the fluids actually used.

The actual values thus obtained show that with nearly saturated zinc sulphate solution (specific gravity 1·4), and very dilute copper sulphate solution, the maximum fall in E.M.F. is developed, being less than ·04 volts; hence of the total fall in E.M.F. produced when moderately strong currents pass only a fraction can be accounted for by the effects of the migration of the ions.

On comparing the above values with those calculable from Thomsen's heat valuations, substantial agreement is found to subsist. When zinc is converted into zinc sulphate, and *pari passu* copper sulphate is reduced to copper, no free sulphuric acid being present, the calculated E.M.F. is sensibly independent of the strength of the solution, and is $1·105 + x$ volts where x is a small quantity, varying with the molecular condition of the deposited copper. When, however, the zinc is dissolved by sulphuric acid, the E.M.F. is greater than 1·105 by a quantity $(a - b)$ where a represents the heat of dilution of the acid used, and b is the heat of dilution of zinc sulphate solution. Since, however, a is + and b is —, the value of the E.M.F. always increases with the strength of the acid. On substituting in various cases the values of a, calculable from Thomsen's data, the calculated E.M.F. quoted in the above table is obtained, y being equal to $-b$.

It results from the non-equality of the total fall in E.M.F. when a current is generated with the effect calculable from the migration of the ions, that when a current passes the energy due to the actions taking place in the cell, although wholly manifested (or substantially so), as electric action expressible in volt-coulombs, when the current is very small, is not wholly so manifested when the current is stronger. The author endeavours to express this idea by referring to that part of the energy which is thus manifested as electric action as being *adjuvant*, and to the remainder (which, of course, makes its appearance as heat, generated otherwise than in accordance with Joule's law) as being *non-adjuvant*. It is evident that the non-adjuvancy may arise either at the surface of the zinc plate which is dissolved, or at that of the copper plate, where copper is eliminated originally in the "nascent" state, but spontaneously transforms itself into ordinary solid electro-copper, giving rise to a gain in energy (evolution of heat) in so doing, or it may arise at both surfaces. In order to gain some information as to the seat of the major part of this effect, the double-plate cell experiments were repeated, making 4 sets of observations instead of 2—*i.e.*, the 4 combinations—(A) larger copper, larger zinc; (B) larger copper, smaller zinc; (C) smaller copper, larger zinc; (D) smaller copper, smaller zinc; being successively opposed by interpolation from the results, series of values were obtained exhibiting the effects produced by halving the area of the copper plate (A and C or B and D compared), or of the zinc plate (A and B or C and D compared), everything else remaining precisely the same. It was thus found that in every case where the strength of the current was sufficiently great to make the differences considerably greater than the observational errors, a much greater effect was produced by halving the area of the copper than by halving that of the zinc plate; so that, finally, the conclusion is drawn that of the total fall in E.M.F. of a Daniell cell on generating a moderately large current, usually referred to under the inappropriate name "polarisation," a small portion only can be accounted for by the effect of migration of ions in causing differences of specific gravity between the fluids surrounding the plates. Of the remainder, the majority is due to actions having their seat at the surface of the copper plate, and the rest to actions having their seat at the surface of the zinc plate.

As a subsidiary result it appears that the E.M.F. of a Daniell cell with zinc and copper sulphate solutions of equal specific gravity pure zinc amalgamated plates, and either freshly deposited electro copper, or amalgamated copper plates, is a tolerably readily reproduced standard, and one subject to less fluctuation between the value of different cells thus arranged than other forms of Daniell cell, and also than Latimer Clark mercurous sulphate cell, the limits of variation being as $\pm$ 0·25 to $\pm$ 0·8 or thereabouts with these forms of Daniell cell and Clark cell. On the other hand, a standard Daniell falls notably in value after a few hours, or a day or two at most, whilst a Clark cell can be so constructed as to remain absolutely permanent in its indications (at a constant temperature) for months, and even one or more years.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

The eighteenth ordinary general meeting of the shareholders of this Company was held on the 14th instant, at the City Terminus Hotel, Cannon-street, under the presidency of Mr. S. W. Silver.

The CHAIRMAN in opening the proceedings expressed his regret at having to inform them that in consequence of illness, their chairman (Mr. George Henderson) was prevented from attending the meeting. He was sure that the shareholders would regret Mr. Henderson's absence equally with the directors.

The SECRETARY (Mr. William J. Tyler) then read the notice convening the meeting, and the report of the directors, which has appeared in *The Electrician*, having been taken as read,

The CHAIRMAN said: It remains for me in moving the adoption of that very satisfactory report to refer to the items generally in it. I do not think they need many remarks from the chair. The state of the accounts we consider to be of a very satisfactory nature, and I think it is matter for congratulation that we, as a trading concern, should be able to pay a dividend of £1 a share, and to set aside £25,000 to add to the reserve fund. That addition simply means that we should have ready money to pay for all our materials, and inasmuch as the out turn of the concern is so much larger in proportion to what it has been, we require an increased balance at our bank. I think that will generally commend itself to all of you as an act of prudence. As I have referred to the increase of the out turn, I am brought to refer to the cause of it. It is with pleasure that I have to allude to the increase in our cable business; and our general business is going on satisfactorily. There is, in fact, nothing to refer to particularly on that point. The contracts for the cables this year have been of a very satisfactory kind. In twenty weeks we have produced over 3,000 miles of cable, and the reports we get from the other side of the world show us that the cables are of the very best and highest character and class. That proves that as manufacturers we really only require a fair field and no favour. We are all here partners in one concern, and you must help us. We look to you to do so. It is rather a close field this contract business, and while my friend on the left (Mr. Gray) is indefatigable in his exertions, and while we—our chairman, particularly—back him up in every way in our power, still we want help from you, and I hope you will turn the matter over in your minds and render us such help as will enable us to maintain for years to come the satisfactory position in which we now find ourselves. On the West Coast of South America we have laid, or we shall do so when the work is completed, a greater length than the Atlantic cable, and therefore you have excellent ground to go on. We are quite equal to the productions of any manufacturer. With regard to the steamship "Silvertown," the purchase of which is referred to in the report, that has rendered us independent of all outside help. We can now go forward and take any ordinary contracts, and that places us in a position we have never occupied before. I must do the chairman, in his absence, the justice to say that he is ever watchful over our concerns from day to day, and hour to hour, and when wanted he is never called on in vain. I am very sorry that he is not able to be here to express his satisfaction at the present position of the Company. I shall be glad to hear remarks from any of the shareholders. I will conclude by moving, "That the report and accounts now presented be received and adopted, and that a dividend of £1 a share, free of income-tax, payable on and after the 15th instant, be now declared,"

Mr. NEIL BANNATYNE seconded the motion, which was at once carried unanimously without discussion.

The CHAIRMAN: The next business is to move the re-election as a director of our excellent and worthy friend and companion in arms, Dr. Beattie. He is attentive to his duties, but on the present occasion, when immediately interested, he is compelled to be absent on account of the illness of a member of his family. He is in the South of France on that account, or he would have been with us.

Mr. BANNATYNE seconded the motion, and it was carried unanimously.

On the motion of Mr. HANSON, seconded by Mr. HORNE, the auditors, Mr. J. Weise and Mr. James Cowan, were re-elected for the current year with a remuneration of 30gs. each.

The CHAIRMAN: I must plead rather an omission that I have made. I had intended to say something about our manager and staff, and I am now going to ask you to join us in expressing our thanks to the manager and his efficient staff. I have reason to say a great deal more than I shall venture to do in our manager's presence. I am sure some shareholder will second the motion, as I propose it, from the bottom of his heart.

Mr. HANBURY cordially seconded the resolution. Time was when their position was very bad, but since then some very agreeable statements had been placed before them, and their position now was so gratifying that they should be very warm in the expression of their thanks. They must feel from what they had heard that they were "at the top of the tree." He had looked well into the statement furnished them of the affairs of the Company, and he could say, being connected with not a few companies, that not one of them stood so high as this Company, looked at from every

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point of view, and as regarded their present and future. In these circumstances they must feel that their hearty thanks were owing to the manager and staff, who conducted their business, and also to the directors, to whom, no doubt, a similar vote would be passed to that which he seconded.

The motion having been carried unanimously,

The GENERAL MANAGER (Mr. Matthew Gray) said: I am very much indebted to you for your vote of thanks on behalf of myself and staff. I should just like to make a few remarks, so that while we are now enjoying the pleasure of success you should not be carried away with any undue hopes of the future. Our business at Persan, our French works, has never been very remunerative. We have, during the last year, added to its power by putting down machinery and buildings suitable to do cable work, and I am glad to say that the orders entrusted to us by the French Government and others have been very successfully done, and it looks as if we shall go on with that business without any interruption, as far as we can see. Therefore, although Persan may not be a very remunerative portion of our business, still I think we may look forward with hope to its remunerating us for the outlay. So far as the Silvertown business is concerned, our general business has been gradually progressing—that is to say, our india rubber, our instrument, and our general telegraph business; and we have felt the need of extending and improving our premises. We have accordingly done so—I would not say to completion, but pretty nearly so; and as we now stand we are very well able to compete with our rivals. In the general business we have active competitors in Manchester and elsewhere, and we are rather weighted by the extra price of coal and a little extra in the price of labour; but we must endeavour, by our superior production, to maintain ourselves in a good position. The business called the general business amounts to somewhere about £300,000 a year. It is fairly remunerative—not by any means excessive—and I hope by attention and care that we shall be able to increase the turn-out a little, and secure a little better profit out of it. That is how we stand in our general business. As to our cable business, as you all know, it is very fluctuating. We have our works now fitted up in such a way that I have not any hesitation in saying that we can produce work equal in quality to any in existence and not more in price. This has been a work of considerable labour, and the shareholders have been patiently waiting till it has been done; and I think we are now in a fair way of competing with our rivals, providing that there is a fair field and no favour. Our works are now capable of producing between 8,000 and 9,000 miles of cable a year—say, 8,000 miles. We have two competitors who are both very able and very enterprising, and we have to meet them almost in every contract that we secure, while they have friends who supply them with orders without competition. With our competitors and ourselves we are able to produce far more cable than is necessary—any one of the three, if kept employed during the year, could manufacture all the cable required by the world. That being so you may ask, "Why, then, increase your machinery?" Well, the reason for that is that contracts are continually brought out, and the work is required in such a hurry that we must have machinery to complete it in what our employers call "reasonable time." Hence the necessity of having ample machinery. You will see from what I have said that we should be careful in estimating our future position. Do not be over sanguine. I am always afraid that in that case you get disappointment, and therefore I want to warn you against being too sanguine. We will do our best, and try and maintain the position we occupy, but I want to warn you that we have active and able competitors, who are men of ability. I have no fear of our future, but I want you to know our position fully. We are quite able to face any of our competitors in open field. I am very sorry that our chairman is not present. He takes the warmest interest in everything that is done, and he is very attentive to the welfare of the shareholders. I cannot too often repeat that to you. We have a very good staff, we are pretty successful in everything we do, and I think with average fortune in the future that we shall not fail in anything entrusted to us.

Mr. BAKEWELL then moved a vove of thanks to the chairman and directors. To their present chairman, he observed, the great success which the Company had attained was largely attributable; nor must the constant support and the vigorous measures of the directors and the efficiency of the staff be forgotten.

Mr. TREBLE seconded the motion, and it was carried unanimously.

The CHAIRMAN: I am sure that we feel the remarks which have been made by the hon. shareholder are undeserved [no, no]. I can only say in reply that I know what he means, and what he refers to; but without our management, and the ability and attention of our chairman, I think we should not meet you here as we do with such great satisfaction. I thank you all for the compliment you have paid to us.

The meeting then separated.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).

The ordinary general half-yearly meeting of the proprietors in this Company was held on Friday, Feb. 10th, at the City Terminus Hotel, under the presidency of Viscount Monck.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting, and the minutes of the last meeting, the report of the directors was taken as read. It stated that the total receipts from the 1st July to the 31st December, 1881, including a balance of £23,545 19s. 4d. brought forward from the last account, amounted to £244,412 11s. 3d. The traffic receipts showed an increase of £4,593 as compared with the corresponding period of last year. The total expenses of the half year, including repair of cables, income-tax, &c., amounted to £59,600 18s. 3d. The directors, under the powers conferred upon them by the Articles of Association, had, before declaring the net profits, set apart the sum of £75,000 to the renewal fund, leaving an available balance of £109,811 13s. Interim dividends of 15s. per cent. on the ordinary stock, and 30s. per cent. on the preferred stock, free of income-tax, were paid on the 1st November last, absorbing £52,500, leaving a balance of £57,311 13s., out of which the directors recommended the proprietors to declare final dividends, free of income-tax, of 15s. per cent. on the ordinary stock, 10s. per cent. on the preferred stock, and £1 per cent. on the deferred stock, amounting altogether to £52,500, making a total distribution for the year ended the 31st December, 1881, of 3½ per cent. upon the ordinary stock, 6 per cent. upon the preferred stock, and 1 per cent. on the deferred stock, leaving a balance of £4,811 13s. to be carried forward to the next account.

The CHAIRMAN, in moving the adoption of the report and the declaration of the dividends therein recommended, observed that it would be, as usual, his duty to make a few observations on the report itself, and on the present state of the Company. Of course the most important consideration on these occasions was the condition of their property, by means of which they earned their income. He was happy to inform them that their cables were all working, and were in good condition. One of the cables had been broken close to the shore at Valencia in one of the storms which occurred last autumn, but he was happy to inform them that since the report was presented that cable had been restored to working condition, and was now doing its duty equally with the rest of their cables. Bad weather—storms, for instance—were unfavourable to cable property. They were injurious to it in two ways—first, mechanically, because they found that the action of the waves in shallow water had a great tendency to fray the cables, and so destroy their efficiency; and that actually occurred the other day in the case of the 1874 cable, the repair of which he had just announced to them. But there was another mode in which storms and atmospheric disturbances affected their cables very much, and that was the effect they had on the electrical conductivity of the cables. When the atmosphere became surcharged with electricity it very often happened that the electrical conductivity of their cables was either diminished or possibly wholly destroyed. Luckily they had escaped anything of that kind this year, but on former occasions it had occurred, and might occur again. He thought that the state of their cables was matter for congratulation. He would remind them that one of their cables, which was working with perfect efficiency (the French cable from Brest to St. Pierre), had now been nearly thirteen years under the ocean. He believed he was correct in stating that it was the oldest Atlantic cable in existence—it had lasted longer than any other Atlantic cable laid down. It had been necessary to take a fault out of that cable, and for that purpose it had been lifted from a depth of 1,700 fathoms—a fact which he considered was matter of congratulation, and one showing that the cable must originally have been of very good stuff. Turning to the accounts for the half year, he had often stated that the true mode of comparison was not to compare successive but corresponding half years with each other. There was little difference between the amounts of the accounts, and the increase which had taken place in the expenditure had been in those items which were most affected by increased business. With regard to the income of the year, it was absolutely impossible to institute any comparison, for this obvious reason—that for the last two years they had been jumping about, so to speak, from one tariff to another in consequence of the competition to which they had been subjected; and no satisfactory comparison could be made between the two half years. He might, however, mention to them that they had had the shilling tariff in operation since the 1st of August last, and the results of that shilling tariff, though by no means recouping the loss they had sustained through going from the three shilling tariff, were very satisfactory so far as they went. Paragraph 9 of their report stated, "The net receipts of the three companies interested, at the reduced rate, have averaged £1,674 per day for the five months ended the 31st December, 1881, including Sundays and holidays, which sum, as compared with the total average net earnings under the same tariff in 1877, shows an increase of £801 per day, equal to about 92 per cent." That was an enormous increase, and justified what he would have to say presently as to maintaining a very low tariff. The primary motive of the reduction of the tariff to a shilling last August was undoubtedly the new competition which had arisen in the United States by reason of the company brought into existence by Mr. Jay Gould. The change was announced at the last half-yearly meeting, and primarily it was a "fighting tariff." At the same time, the directors thought that, having already made three arrangements with other companies which had sprung into existence, it was time they should adopt measures for informing themselves thoroughly what the effect of a low tariff would be on the traffic—that was to say, whether they could count on such an increase of traffic by a low tariff as would fill all the cables, and give an opportunity of making an income to all the companies concerned. There were two alternate systems of policy when competition arose. One was to make an arrangement with their new competitors, and give them by agreement a portion of the income. That was the principle upon which they had previously gone—that hitherto had been the foundation of their policy. It undoubtedly had the recommendation that by means of it the tariff could be kept up, and as the traffic with a high tariff had a normal and natural increase, they might be able, though only receiving part of the gross income, to pay under it a good dividend. This consideration, however, had a limit. They could not go on for ever dividing the gross receipts, and by keeping the tariff up they very naturally prevented the increase which they had seen take place in their income under a low tariff. Those were the considerations for and against the principle which had hitherto guided their policy. They had now to consider what would be the probable effect of adopting the opposite policy—that was to say, declining any further arrangements with competitors, going in for a low tariff, and endeavouring by that means so to stimulate the traffic as to produce a trade which would fill all the cables in existence, and so get rid of competition by the opposite means from that by which they had hitherto sought to neutralise it by agreements. The desire to obtain information which would enable them to arrive at a sound conclusion on that question was one of the motives which induced them to reduce the tariff to 1s.; but they did not think it had been in operation sufficiently long to justify them in arriving at any conclusion as to whether it ought to be the basis of their future policy or not. He had been their chairman now for eight or nine years, and he was bound to say that during the whole of that time they had been seldom out of "hot water." The inducements, whatever they might be, which impelled capitalists to bring new cables into operation seemed to be so overpowering that no considerations of probable profit or loss would deter them from embarking in the enterprise. On former occasions, when they had had the same kind of trouble, he had appealed to them to have confidence in the directors. He was bound to say that he had never

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appealed in vain, and he trusted that the conduct of their directors, and their efforts to maintain the proprietors' interests had justified this confidence. He was about to make a similar appeal on the present occasion. They were in presence of a great contest with a gigantic financial company in the United States, and any indiscretion, either in word or action, on their part might very materially influence the effect which the contest might have on their interests. He did not wish to have any reserve with them, and he had told them the policy they were aiming at, but he did ask them, if they trusted the board, to trust them wholly, and allow them to exercise the best judgment they could in the management of this great contest. He had received letters from one or two shareholders referring to the diminution in the market value of their property, and suggesting means by which this might be neutralised. If the directors could appreciate their property in the market it would give them great pleasure to do so, but the depreciation was attributable to the continuous competitions to which they had been subjected, over which they could have no control. A suggestion made by one of the writers—whom he had not replied to, not from any want of courtesy to the writer, but because he thought it better that the answer should be given at the general meeting—was that the reserve fund should be made use of to purchase in the market a large amount of the stock and cancel it, thereby increasing the value of the *residuum* by diminishing the quantity of stock in the market. It would be inconsistent with their Articles of Association to do this. It was true that the Articles might be changed, but such an alteration would give the directors the power of jobbing in the market in their shares, and every rise or fall would be attributed to sinister action on the part of the directors. He did not believe that Aristides himself, if still in existence, could maintain his character against the insinuations that would be cast on the directors under such circumstances. He would submit to any amount of labour and undertake a great deal of responsibility to promote the interests of the Company, but he confessed he did not think he could incur the responsibility of undertaking such an operation as that. He had endeavoured to lay before them without reserve the state of their enterprise and the principles upon which the board hoped to manage it in future as they had in the past. Speaking for all his colleagues and himself, he could assure the proprietors that their sole object was the maintenance and improvement, as far as possible, of their property, so as to make it more valuable in the market and more productive to the shareholders. He concluded by moving the resolution.

The Hon. ROBERT GRIMSTON seconded the motion, when a discussion followed, which was taken part in by Messrs. Smith (who moved an amendment increasing the dividend), Weir, Denison, Prust, Thorn, Griffith, Jackson, and Newton.

The CHAIRMAN, in reply, at the close of the discussion, stated that the repairs made during the past year had been paid for out of income, except as to a portion of cable which they had in stock, which had been used, and which had, of course, so far reduced the stock of the renewal fund. The duplex system was first applied in 1878 to one of their cables, and it had since been gradually applied to all of them. The arrangements they had made with the Direct and the French Companies were entirely of a reciprocal character. In the event of the cessation of the working of any of their cables, what was given up by one company would be made good to it should it subsequently have a similar mischance. By the arrangements which had been made, the deferred stockholders would only have what remained after paying the preferred and the ordinary stockholders. They gave the deferred stockholders all they could, but they could not starve the reserve fund in order to give them more. As to their having adopted the reduced tariff too soon, if they had reduced the tariff merely for fighting purposes they were bound to start as early as possible, but, as he had said, they had waited to see the effect on their income of a low tariff. He had so often expressed his views as to the importance of a substantial reserve fund that he would ask Mr. Grimston to let the shareholders have his views. He could not put Mr. Smith's amendment. The shareholders could not propose any increase in the dividend recommended by the directors, though they might propose that it be decreased.

The Hon. ROBERT GRIMSTON stated that in his opinion maintenance was the first necessity of a telegraph company—he said "necessity," because, unless they had their lines in working order, they would have no revenue whatever. In a land telegraph maintenance was the first charge, because poles, wires, and insulators were repaired and renewed from day to day, and week to week, and the lines were kept in perfect order; but with a cable under the sea this could not be done. Therefore, the only way to maintain a submarine cable was to lay by a sufficient sum from time to time to replace it when it was utterly worn out. Unless they did that they would not earn a shilling fairly, and until they did it every dividend paid was really so much capital. That being so, he should have thought that every business man would agree to the principle, the only difference of opinion being as to the amount of the renewal fund. When this Company was first formed they laid two cables (those of 1865 and 1866) and it had constantly been cast in their teeth that both failed within ten years, and that both were defunct. He must admit that both failed within ten years, but he denied altogether that they were defunct, for without borrowing a shilling, or creating any preference stock, or clogging the Company in any way, they had replaced both in the only legitimate way—by maintenance out of revenue. The 1869 cable did its work fairly well, and he hoped it would continue to do so, but it was gradually wearing out, and the time would come when it would utterly fail. When that happened it was their desire to go into the market with ready money and buy a new cable, which would represent the 1869 cable as efficiently as the 1865 and 1866 cables were now represented. Under this, the only proper system of maintenance, a cable, like the Sovereign, never died. He had heard no alternative suggested by any of the speakers for renewing the cables when worn out, or any substitute for the renewal fund. The object of the directors was to make the property of a sound and solid character. With that object, for the renewal of the cables they placed £75,000 to reserve every half year—£150,000 a year, or rather more than 2 per cent on their capital; and he was sure they could not do with anything less if the property was to be efficiently maintained. To starve the renewal fund would be a suicidal policy, and would lead to the bankruptcy of the Company.

The MANAGING DIRECTOR (Mr. H. Weaver), in reply to Mr. Newton, stated that there had been no block in the cable since the shilling tariff had been in operation, but during the time that the 1874 cable was out of order the delay had been much longer than usual. That cable was now repaired, and the average delay of a message between London and New York was thirty minutes all the day through.

Mr. UNDERDOWN having pointed out that the Stock Exchange would not allow a quotation to any company which dealt in its own shares,

The CHAIRMAN, in reply to Mr. Thorn, stated that they wanted by means of the renewal fund to replace each cable as it failed. They had four cables, and at present they had not enough money to replace one. The increase of the traffic under the one shilling tariff had made up the deficiency in the receipts caused by the reduction of tariff to the extent of 67 per cent.—The motion was carried unanimously.

The retiring directors and auditors were then re-elected, and with a vote of thanks to the Chairman and Directors the proceedings terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES FEB. 15.		BUSINESS DONE WEEK ENDING FEB. 15. Highest.		Lowest	
Anglo-American	49¼,	50¼	50¼		50	
Do. Preferred	78,	79	79		78	
Do. Deferred	19¼,	20¼	21¼		20¼	
Brazil Submarine	11,	11¼	11¼		11	
Cuba	8¼,	9	—		—	
Do. Preference	15¼,	16¼	—		—	
Direct Spanish	5¼,	5¾	5¾		5¾	
Do. Preference	14¾,	15¼	—		—	
Direct United States Cable	10¼,	10½	10¾		10¼	
Eastern Telegraph	9¾,	10¼	9 15-16		9¾	
Do. 6 per Cent. Preference	12¾,	12¾	12¾		12¾	
Do. 5 per Cent. Debentures, 1899	102,	107	104¼		104¼	
Eastern Extension	10¾,	11¼	11¼		11	
German Union	9¼,	9¾	9¾		9¾	
Globe Telegraph and Trust Company.	6,	6¼	6¼		6 1-16	
Do. Preference	12¼,	12¾	12¼		12¼	
Great Northern	11¼,	12	12		12	
Indo-European	28,	29	—		—	
Mediterranean Extension	2¼,	2¾	2¾		2 11-16	
Do. Preference	9¼,	9¾	9¾		9¼	
Reuter's	12¼,	13	—		—	
Submarine	270,	280	273		273	
West India and Panama	1¼,	1¾	1¾		1 11-16	
Do. 1st Preference	7¼,	8	7¾		7 11-16	
Western Brazilian	8¾,	9	8¾		8¾	
West. Union 7 per Cent. 1st Mortgage	123,	128	—		—	
Do. 6 per Cent. Sterling Bonds	104,	107	—		—	

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1¾		1 5-16
Oriental	¾,	1	—		—

ELECTRIC LIGHT.

Electric Light and Power	1,	1¼	1¼		1¼
Anglo-American Brush	8¾,	9¼	9¼		9¼
United Telephone	12,	12¼	12¾		12¾

TRAFFIC RECEIPTS FOR JANUARY, 1882.

COMPANIES.	Jan., 1882.	Jan., 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,800	2,527	273	—
Direct Spanish Telegraph Company	2,055	1,506	549	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,129	29,434	3,695	—
Eastern Telegraph Company	53,648	47,445	6,203	—
Great Northern Telegraph Company	16,960	17,353	—	393
London-Platino Brazilian Telegraph Co.	1,868	1,990	—	122
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—

ELECTRIC LIGHTING OF STRASBOURG STATION.—Further details of the electric lighting of this station state that the machines are situated in a wooden shed near the level crossing of Bastion-street. The engine is a portable engine of 20 h.-p., which works two Siemens magneto-electric machines and one Edison machine. The engine, which works from 4 p.m. to 7 a.m., consumes about 1,200 kilos of coal per day (a kilo = 2·2 lbs.). The Siemens machines, which have been working since July, 1880, are driven at a speed of 1,180 revolutions per minute. These furnish a current for 20 lamps of different sizes; 12 small ones fixed in the waiting room, with a candle-power estimated at 150 candles; 6 medium size of about 350 candle-power, and 2 large ones of 1,200 candles. The two latter are only lighted after midnight, and are erected, one near the engine shed, and the other near the old rampart. The Edison machine supplies current to 80 incandescent lamps (Edison) of from 16 to 20 candle-power, which serve to light the refreshment room and the station offices, as well as the shed where the machines are working.

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SLIP

ELECTRIC LIGHT AT LYONS.—Experiments are being made with two Siemens lamps as illuminators of the Place des Celestins at Lyons.

SS. "INTERNATIONAL."—The India Rubber and Gutta Percha Works Company's cable ship "International" arrived in the Thames on Saturday last.

ELECTRIC LIGHT AT MARSEILLES.—Two of the principal cafés at Marseilles, the Café Glacier and the Café du Commerce, are lighted by the electric light.

AN ENTERPRISING GAS COMPANY.—The manager of the South Australian Gas Company at Adelaide reports himself ready to lay on the electric light if required.

TELEGRAPHS INTERRUPTED.—The heavy gales experienced on Friday and Saturday of last week, in Cheshire, have done considerable damage to the wires on the Chester and Holyhead lines.

ELECTRIC LIGHT FOR HARWICH.—The Town Council of Harwich have received a numerously-signed petition, asking them to take steps to ascertain the cost of lighting the town by electric light.

THE TELEPHONE AT ADELAIDE.—According to recent news from South Australia, the Government were making arrangements in December last for the establishment of a telephonic exchange.

SUPPLEMENTARY ESTIMATES.—Amongst the supplemental estimates of sums required for the year ending March 31, 1882, we notice subsidies to telegraph companies £5,526, and Post Office Telegraphs, £80,000.

GREAT NORTHERN TELEGRAPH COMPANY.—The Shanghai-Hong Kong and Shanghai-Amoy cables have been repaired, and telegrams for Hong Kong, Manila, and Amoy are, therefore, again accepted by this company.

GREAT NORTHERN ELECTRIC LIGHT COMPANY.—This is the title of a new undertaking that was registered on the 2nd inst., with a capital of £10,000, to acquire the sole right to the use of the Pilsen arc electric lamp for New Southgate and the neighbourhood.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 17th February, 1882, were £2,583 after deducting the "fifth" of the gross receipts payable to the London Platino-Telegraph Company (Limited).

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The eighteenth ordinary general meeting of this company will be held at the offices, 38, Old Broad-street, E.C., at one o'clock on the 28th inst. The report of the directors will be found in another column.

ELECTRO-MOTORS AND THE ST. GOTHARD TUNNEL.—The *Giornale dei Lavori Pubblici* for January 25 emphatically contradicts the report that the St. Gothard Railway Company is in treaty with Messrs. Siemens and Halske, of Berlin, with a view to the use of electric locomotives for the tunnel service.

CARDIFF AND NEWPORT TELEPHONE EXCHANGE.—The increase in the number of firms who have availed themselves of the telephonic communication between these two towns has induced the Post Office to erect an additional double wire trunk circuit between Cardiff and Newport. This was successfully opened on Wednesday week.

COUPONS.—It is notified that the coupons falling due and the bonds drawn for payment on the 1st March next of the Western Union Telegraph Six per Cent. Sterling Loan will be paid on that or any succeeding day by Messrs. Morton, Rose, and Co., Bartholomew-lane, E.C. The coupons and bonds must be left three clear days for examination.

PHYSICAL SOCIETY.—To-day (Saturday), at 3 p.m., the following papers will be read before this society at South Kensington, viz.:—"On the Influence of the Form of Conductors on Electric Conduction Resistance," by G. Gore, and "On Faure's Accumulator, and on a Simplified Form of Dispersion Photometer," by Professors Ayrton and Perry.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for January were £2,800, against £2,025 for the corresponding period of last year, showing an increase of £775. For the half month ending Feb. 14, the gross receipts amounted to £1,875, against £900 for the corresponding period of 1881, being an increase of £975.

TELEGRAMS FOR CHINA.—The Eastern Telegraph Company notifies that in consequence of the interruption of the Great Northern Company's Nagasaki-Shanghai cable, mentioned in another note, telegrams for China can only be transmitted *via* India. Telegrams sent from postal stations should be directed "*via* Eastern," these words being signalled free of charge.

ELECTRIC LIGHT FOR RADCLIFFE (LANCS.).—At a recent meeting of a committee appointed to watch over the interests of the gas consumers in the Radcliffe and Pilkington gas supply district, held at the Local Board Offices, Radcliffe, a sub-committee was appointed to obtain tenders or estimates from the electric light companies for lighting houses, mills, workshops, and open spaces in the district.

WRIGHT V. ELECTRIC POWER COMPANY.—All persons holding debentures of this company, Class B, are required, on or before the 10th March, to send their names and addresses, the amounts and distinctive numbers of their debentures, and other particulars of their claims, and the names and addresses of their solicitors (if any) to Mr. Alfred Elborough, No. 51, Queen Victoria-street, E.C., the receiver in this action.

CABLE INTERRUPTED.—The Great Northern Telegraph Company notify the interruption of their Nagasaki-Shanghai cable. Telegrams for China cannot, therefore, be accepted by the Company until further notice. The break is near to the shore, and the Company's repairing steamer having left for the spot, a speedy restoration of the cable may be expected. The Company's lines to Japan continue in good working order.

"THE THEORY OF ELECTRO-DYNAMIC PHENOMENA."—This is the title of a long article from the pen of M. J. Moutier in *La Lumière Electrique* for the 18th inst. The article is copiously illustrated. In the preface the writer regrets that Ampère's law should have been "relegated to an obscure place in the second rank," whilst "magnetic phenomena, which were first explained by means of Ampère's theory, have assumed priority."

THE FIRST TELEGRAPH LINE IN FLORIDA.—According to the Pensacola *Gazette* the first telegraph line in West Florida was constructed from Pensacola to Blakely, and was put up mostly on trees along the mail coach road. The line crossed from Blakely, Alabama, to Mobile by cables and on poles along the marsh. It was completed and operated first

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in the month of January, 1860, and was known as the Pensacola Telegraph Company.

SUBMARINE CABLES.—A letter has been received by Mr. John Pender, M.P., in answer to the communication lately made by him to the Board of Trade on the above subject (see our last issue, page 215), in which the Board ask for the following information, viz.:—"First, a map showing the position of all the present telegraph cables; secondly, a set of clauses completely drawn and embodying the provisions which the companies wish to see made law."

TELEPHONIC COMMUNICATION AT LUTON (BEDS).—Telephonic communication has been established between the Post Office at Luton and the mansion at Luton Hoo. A cable is laid in a trench, two feet deep, from the house to a wood 400 yards distant; the wire is then suspended from the trees and carried to the railway telegraph poles close to the New Mill End Railway Station, from whence it is carried to the Post Office. The telephone used is the Gower Bell.

ELECTRIC LIGHTING, &c., BILLS.—The following Bills have been read a first time, viz.:—Anglo-American Brush Electric Light Company, brought in Feb. 13, read Feb. 14; British Electric Light Company, brought in Feb. 13, read Feb. 14; Charing Cross and Waterloo Electric Railway, brought in Feb. 13, read (second time) Feb. 20; Edison's Electric Lighting Company, brought in Feb. 13, read Feb. 15; Electric Light and Generator Company, brought in Feb. 13, read Feb. 14.

ELECTRIC DISCHARGES.—In a recent number of *Wiedemann's Annalen*, Herren Reitlinger and Wachter deal with the question of electric discharges. After careful examination or Lichtenberg's figures, they conclude that the positive and negative discharges differ essentially. The positive discharge alone produces starlike or radiating effects. Sometimes it may take annular forms, analogous to those of the negative discharge, but the latter never takes the starlike shape which is peculiar to the positive discharge.

THE TELEPHONE IN MILAN.—An Italian paper says that Signor Pianta, the manager of the Compagnie Générale des Telephones in Italy, proposes to transmit the opera "Lohengrin," which is being played at Venice, by telephone to Milan. The same authority adds that this gentleman has introduced modifications into his transmitters which greatly increase their powers, and that he has used them successfully over distances of 120 kilometres (nearly seventy miles) without interfering with the distinctness of the sounds transmitted.

THE SS. "LADY CARMICHAEL."—The Submarine Telegraph Company's cable steamer "Lady Carmichael" returned to Dover last week, after a two months' voyage in the North Sea. The vessel left Dover on the 28th of December to repair four cables which were broken during the gales of last autumn. The work has now been effectually accomplished by Mr. Bordeaux, the company's engineer, and would have been done much sooner but for the hindrances occasioned by the large fishing fleet engaged in the North Sea at this time of the year.

THE HOUSE OF COMMONS.—On Monday last Mr. Chamberlain stated, in reply to Sir J. M'Garel-Hogg, that his attention had been called to the various Bills with reference to electric lighting, and he hoped at an early date to be able to introduce a public Bill dealing with the whole question, and laying down the conditions under which these and similar Bills might be suffered to proceed. A petition praying to be heard in Committee against the Charing-cross and Waterloo Electric Railway Bill has been deposited on behalf of the Conservators of the River Thames.

ELECTRIC LIGHT ON SHIP-BOARD.—During the night of Wednesday week experiments were made to test the electric light on board the Russian war-ship "Peter the Great," at anchor in the Clyde. The river and firth were brilliantly illumined for miles in which ever way the light was reflected, the Helensburgh shore being distinctly seen when the light was turned in that direction. A Glasgow contemporary in describing the effect of the light says that "though the atmosphere appeared quite clear in its normal state, when the electric light pierced it a thick haze seemed to prevail."

THE SHETLAND CABLE.—Towards the latter end of last week it was ascertained that the break in the Shetland cable which took place during the thunderstorm on the morning of Tuesday week is in Stronsay Firth, where the current between the Atlantic and German Ocean runs at a great pace between the islands of Stronsay and Shapinshay, in Orkney. The repairing steamer "Morna," according to the latest account, could get nothing done owing to the stormy weather. It is expected she will also have to lift the Stronsay cable before communication with Shetland can be restored.

POST OFFICE TELEGRAPHS.—According to a Parliamentary paper published this week, containing the accounts of the Postal Telegraph Department for the year ended 31st March, 1881, the amount raised on capital account was £10,655,371. The revenue for the year was, upon message receipts and private wire rentals, £1,592,948; the value of free services rendered to Government was £19,479. These sums, together with extra receipts (£21,459) amounted to £1,633,886. The expenses, salaries, wages, and maintenance amounted to £1,181,324, the profit being £440,460, equal to a dividend of 4 per cent. on the capital expended.

TELEGRAPH CLERKS IN LONDON.—In a letter to the *Echo* of the 22nd inst., "A Metropolitan Victim" writes "Not only has the recent revision failed to attract the required candidates, but it has utterly failed to mete out justice to those already in the service, and who have suffered during the last six years from the stagnation which has prevailed. From 1875 to 1881 promotion was at a standstill, the consequence being that clerks of nearly twelve years' service in the London districts are now receiving something less than 27s. a week. Compare this with your 'bricklayer,' and you see how advantageous a change of occupation would be to the overworked telegraphist."

TELEPHONES IN FRANCE.—The number of lines owned by the Société Générale des Téléphones in Paris on the 31st January was 1,411, as compared with 626 at the same date last year. As regards other towns the following are the figures for 1881 and 1882 respectively; in Lyons the company owned 37 lines in 1881, and 285 in 1882; in Marseilles the figures were 32 and 153; in Nantes, 14 and 70; in Bordeaux the number of lines in 1882 were, 132; in Havre, 100; in Lille, 5. The increase in the number of subscribers was as follows:—Paris, from 1,015 in 1881 to 2,200 in 1882; Lyons, 60 to 249; Marseilles, 14 to 166; Nantes, 25 to 79; Bordeaux, 29 to 168; Havre, 21 to 129; Lille, 0 to 79.—*La Révue Industrielle.*

ELECTRIC LIGHT FOR TRAINS.—*La Lumière Electrique* says that an experiment was made a few days ago on the railway at Milan with a view to introducing the electric light into the trains of the Central Railway. A carriage was lighted by means of the Edison lamp, and the experiment was so successful that it is proposed to light a whole train in

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this way. Information from another source says that experiments with the electric light for trains took place at Frankfort on the 3rd of this month on the Frankfort-Hanau Railway. A dynamo machine was driven by mechanism connected with the axles of the brake van, and Faure accumulators were used to store the electricity. We have no details of the experiments, but they were said to be successful.

Swan's Miners' Lamp.—Mr. Swan was to have lectured a few days ago at the Wood Memorial Hall, Newcastle-on-Tyne, on his portable miners' lamp. Owing to illness, however, he was unable to attend, and the lamp was exhibited and explained by Mr. J. Buxton Payne. The lamp is the outcome of suggestions by Messrs. Crompton, Graham, and Jamieson. In the course of the discussion which followed the paper the question was raised whether, if the lamp was broken in a gassy pit, an explosion would follow. Mr. Payne promised that Mr. Swan would make an experiment to ascertain whether such would be the case. The lamp consists of the ordinary Swan incandescent lamp of about 2 or 3 candle-power, attached to a box containing a secondary battery.

Selenium and the Photophone.—Professor Manfredo Bellati and Dr. R. Romanese have investigated the rapidity with which light modifies the electric resistance of selenium. The question has a practical bearing upon the construction of the photophone, since, if the time required to produce this change were considerable, the most rapidly vibrating sounds would become confused or inaudible in transmitting them. When light falling on a selenium cell was interrupted 1,250 times per second, the resistance was practically the same as with a far less rapid interruption giving equal average illumination. All the experiments of these gentlemen led to the result that selenium behaves sensibly as if the variation of resistance by the incidence of light were effected instantaneously.—*Nature.*

Crystal Palace International Electric Exhibition.—On Wednesday night Professor Sylvanus P. Thompson inaugurated his series of lectures at the Crystal Palace by one on "Electric Currents—What are they?" The other lectures will deal with the subjects, and be delivered on the dates that follow, viz.:—"Electric Currents—How to make them by Steam," March 1; "Electric Arc Lights," March 8; "Electric Incandescent Lamps," March 15. The lectures will be delivered at eight p.m., and will be illustrated by magic lantern diagrams and experiments. Admission will be by ticket. Particulars as to prices, &c., can be had of the manager. We believe that other lectures on the various systems of electric lighting are being arranged.—Both the Swiss and the United States Governments have appointed a delegate to inspect and report on the various exhibits now on view at the Crystal Palace.

The Distribution of Power by Electricity.—M. Marcel Deprez, in a note on this subject presented to the French Academy of Sciences on the 13th February, gave the following particulars of some experiments which he had carried out with small Gramme machines weighing about 100 kilos. (220lb.):—"I obtained useful work to the amount of 37 kilogrammes (about 81lb.), the resistance between the motor and receiver being 786 ohms, equal to a distance of 78·6 kil. of ordinary telegraph wire. To render the figures more comprehensive, I will place the various data of the experiment side by side with those obtained by M. Fontaine, with larger machines. Fontaine: Speed, 1,570 revolutions; useful work, 21·5 kilog.; work per revolution, ·8 kilog.; return, ·38; resistance interposed, 4·65 ohms. Deprez: Speed, 2,300; useful work, 3·80; work per revolution, 1; return, ·25; resistance interposed, 786. The above was accomplished without any sparking or heating of the machine, and without any special precautions as to the insulation of the conductors being taken."

Metropolitan Board of Works.—At a meeting of this board last week, the following recommendations from the Works and General Purposes Committee having reference to the Electric Lighting Bills now before Parliament which affect the metropolis were adopted, viz.:—(*a*) That so far as the proposed works may interfere with the streets of the metropolis, they should only be executed subject to the approval of the board; (*b*) That no company should be considered to have any monopoly of supply, or any right hereafter to claim any compensation in respect of any additional supplies which, in the interests of the public, it may be thought proper to encourage; (*c*) That there should be an obligation to supply the public and private consumers; (*d*) That the price to be charged and the quality of the electric light, and the dividends to be paid by the company should be fixed subject to revision by the Board of Trade; (*e*) That a sum should be paid for the privilege of carrying the electric wires through, under, or above the public highways of the metropolis. The amount to be settled by arbitration in case of dispute; (*f*) That proper clauses should be introduced for the protection of the Main Drainage Works.

The Dangers of Electric Lighting.—The following remarks are from a preliminary report on this subject, issued by the Boston (U.S.A.) Manufacturers Mutual Fire Insurance Company. After alluding to the danger of contact being made between telephone and other wires and electric light wires, the report says:—"There is another danger, which may also be easily avoided, but of which notice should be taken at once by every member using an electric arc light, or contemplating such use—namely, it appears that if the wire conveying the current is suddenly fractured while the dynamo machine is in operation, the voltaic arc is extended while the ends of the wire are separating, through several feet of distance, varying according to the power of the machine—that is to say, if the wire is broken at such a place that one end can fall or separate from the other, the voltaic arc, or what would be called in common speech the electric spark, will follow from one broken end to the other, from one to six feet, according to the power of the current generated. . . . The greatest care should, therefore, be taken in choosing the position of the wires; and they should never be carried along the underside of the beams and transverse thereto, or in any proximity to belts, shafting or pipes. . . . In dye houses, bleacheries, print works, paper mills, and other works where wet processes are in use, the greatest care must be taken that the two wires do not come in contact with the same surface of damp or wet wood, as in such case a cross arc may be formed upon the wood; and it appears that, if common salt is in the water, and perhaps other salts, the danger of a cross arc upon the wood is very much increased. Salt being used in whitewash, a damp surface of wood whitened may be most dangerous. By 'cross arc' is meant the diversion of the electric current from one wire to another across the damp or wet woodwork. . . . It may be added that we have not yet found any cause of danger of fire, from the use of the electric method of lighting, which may not be avoided, if the right method and proper care be used in putting up and operating the apparatus; but electricity is a force which cannot be too carefully controlled, directed and watched, if generated in currents of considerable intensity."

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CRYSTAL PALACE EXHIBITION.

The Electric Light and Power Generator Company's Exhibits.

The one inconvenient feature in our work of to-day is the long, cumbersome title of the company whose exhibits we wish to describe. Would that every company and firm were compelled to have a short title—they might keep their long ones carefully stowed away in deed boxes or iron chests, anywhere, in fact, so long as the British public were considered. We read in some philological book of our schoolboy days that one of the characteristics of the English nation was to shorten, whenever possible, the words to be pronounced—hence can't and won't, and so on. What a pity it is that promoters and directors have not this characteristic! Having had our grumble, we may say that on various grounds we feel inclined to speak very highly of these exhibits. Great energy was shown by the management, and the plant was the first to be in working order. Then both arc and incandescent lamps are among the best in the exhibition. We, indeed, think that the powers of the electric light are shown to better advantage by one single Weston lamp in one of the side courts than in any cluster or array of lamps in any other part of the exhibition.

The exhibits consist of Weston arc lamps and Maxim incandescent lamps, the current being supplied by Weston and Maxim machines respectively, these machines being driven by one of Ransome's engines. We have not previously illustrated these machines or lamps, and before we enter into the detailed account we may give for comparison with other figures the results of the tests made by Professor H. Morton, and given in the annual report of the Light-house Board to the U.S. Government (page 50). These tests were very elaborate, and so far as we know have never been published in England. They were made in the earlier days of the introduction of the electric light, viz., in 1878 and 1879. The machines were tried with arc lamps, and with the carbons in different positions. We shall quote only the results from the second series of experiments, commenced in November, 1879. (See Table on following page.)

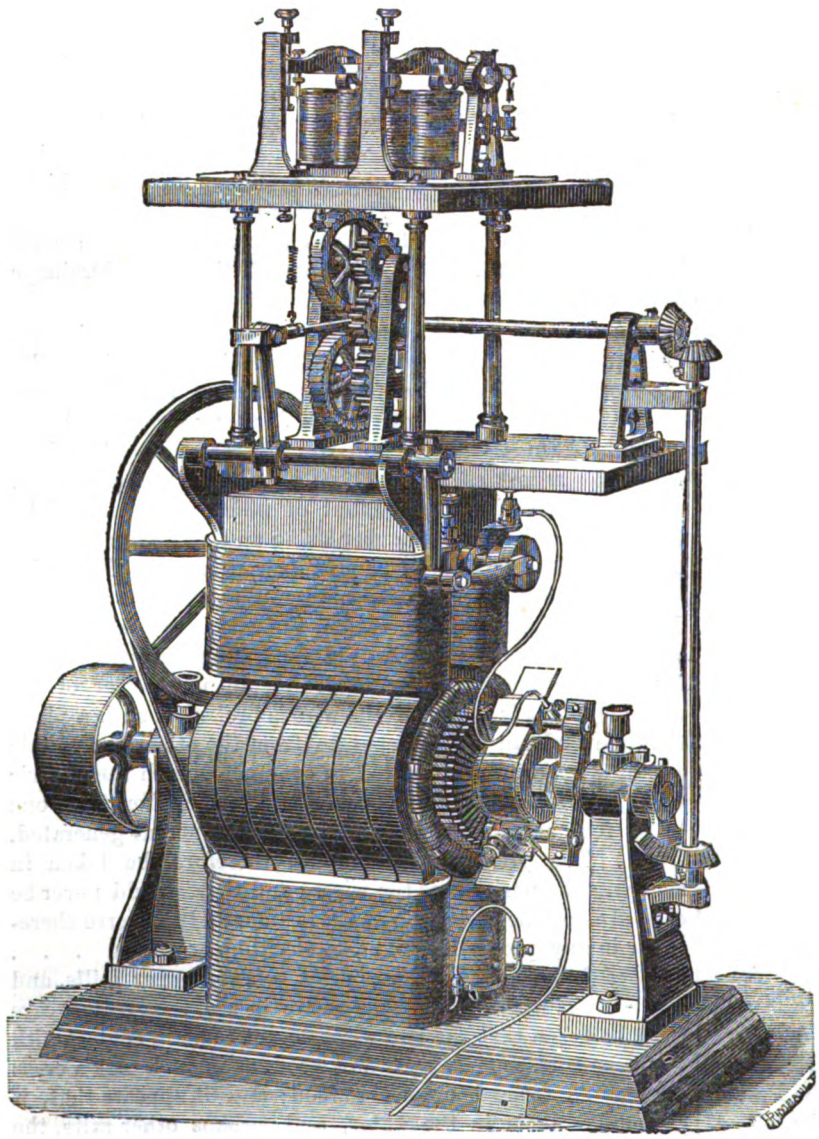

Fig. 1.

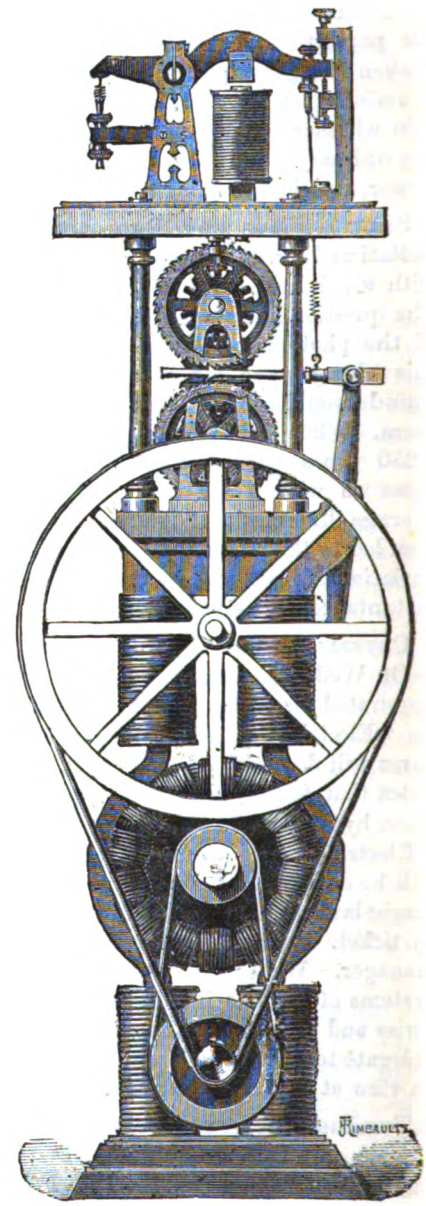

Fig. 2.

We shall take an early opportunity of giving the results of these experiments in detail; meanwhile, however, it will be seen that the Weston machines compare very favourably, as regards results, with the others, although the Maxim machine does not take such a good position. We have long ago come to the conclusion that no machine is seen at its best when tested indiscriminately, but should be used for the purpose and with the lamp for which it was designed, and it may be that the Maxim machine would have compared more favourably with the others had the trials been with incandescent lamps.

The accompanying illustrations will give the reader a good

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idea of the machine. Usually two machines are used, one as an exciter, the other as a distributor. Figs. 1 and 2 show a side and end view of the exciter fitted with its regulating apparatus. Fig. 2 shows clearly the arrangement of coils in the armature. The distributor, Fig. 3, differs somewhat from the exciter. Besides being larger it has two commutators, C C, one at each end of the armature, and the armature coils are wound so that No. 1 coil is connected to one commutator, No. 2 coil to the other, and so on alternate coils to the commutators. In Fig. 3 the machine is shown connected up as a self-exciter. F M indicates the field magnets, which are similar to those of the Siemens machine, only placed vertically instead of horizontally, with the coils connected in series. S S S are iron bars forming the pole pieces, the bars on one side having a south polarity and those on the other a north polarity.

TABLE 27.—*Table of Averages.*

Machine.	Lamp.	Average candle-power.	Average horse-power.	Average candle-power per horse-power.
Maxim (ordinary type)..	Maxim	3,297	5·483	729
Maxim	Hand Lamp	3,930	5·585	704
Siemens	Siemens	4,651	4·863	956
Siemens	Maxim	4,548	4·742	959
Weston	Hand Lamp	8,585	4·769	1,800
Weston	Maxim	7,787	4·683	1,663
Weston	Siemens	7,262	5·056	1,436
Weston	Weston	6,063	4·552	1,332
Maxim (with magnets of low resistance)...	Maxim	7,524	7·400	1,017
Brush	Brush	4,365	2·8467	1,533
Brush	Siemens	3,532	2·9573	1,194

The armature makes about 900 revolutions per minute, and is wound similarly to the gramme. In shape it forms a cylindrical tube about 15in. long by 12in. in diameter. The winding consists of 16 helices of insulated copper wire, each helix consisting of four wires, the ends of which are connected to the 64 sections of the commutators. This duplicate armature can by means of the switch board B be connected in series. The switch board is made of four brass segments 1, 2, 3, 4 (Fig. 4), which are insulated from each

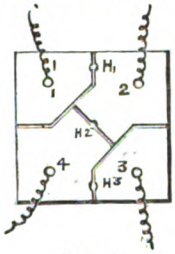

FIG. 4.

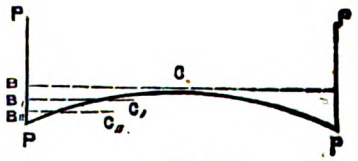

FIG. 6

other, but can be connected by contact plugs at H_1 H_2 H_3. Each segment has a binding screw, R R (Fig. 3), to which can be arranged wires to connect the segments with the upper or lower brushes or the line circuit as may be required. The armature coils would, of course, be connected in series for intensity, and parallel for quantity.

The regulating arrangement depends for its efficiency upon its power to move the brushes of the exciting machine. The brushes are carried on a rocking frame capable of a slight rotation on the axle. The rocking frame ends with a bevel arc, which gears into a bevel wheel at the bottom of a vertical shaft, which shaft carries another bevel wheel at the top, gearing into another wheel on a horizontal shaft. At the other end of this shaft a spurwheel gears into two others (Figs. 1 and 2). An oscillating pawl between these wheels has a reciprocating motion communicated to it by a rocking lever (Fig. 2). Above this wheelwork is a table, on which two electro-magnets are fixed, one having a much higher resistance than the other. Above the upper pole of the magnet, with the higher resistance, is a lever carrying an armature, the lever being balanced by an adjustable spring. The action of this regulating gear—to be explained presently—is to cause the rocking frame, carrying the brushes, to move in one direction or the other, thus carrying the brushes towards or from the position of greatest efficiency. If the brushes are carried from the point of greatest efficiency they collect less current, and so a less current passes into the coils of the distributing machine, and the line current is also proportionally decreased. To effect this operation the regulating electro-magnet is placed in a shunt circuit from the line circuit. The resistance of this shunt circuit is constant, say x, while the resistance of the line circuit varies continually, being at any given moment, say y. For simplicity, suppose the ratio of $x : y = 9 : 1$. The total current being equal to, say, $Z = x + y$ equal parts of this current, $\frac{y}{x+y}$ parts of the current pass through the shunt, while $\frac{x}{x+y}$ parts go through the line circuit, or, using the figure, 1-10th goes through the shunt and 9-10ths into line.

Suppose the lever and spring adjusted, an increase or diminution of current through the shunt increases or diminishes the pull on the armature. The motion is communicated to the pawl, which will either gear into the upper wheel or into the lower, setting the countershafts in motion, and so to the rocking frame and brushes. The arrangement looks very pretty, and in theory ought to act in moving the brushes; but whether this is the right method of regulation or not is a question which we will not now discuss. The apparatus was not working automatically when we saw it, but the brushes were adjusted and the apparatus fixed by the engineer in charge.

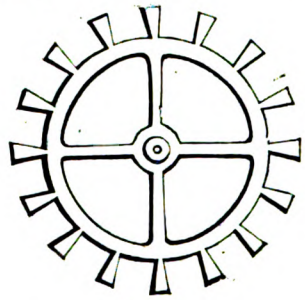

FIG. 7.

The Weston machine, also exhibited by this company, is illustrated in Fig. 5. This machine is similar to the machines used to generate the current for the Weston lamps in Queen Victoria-street, &c., and the other lamps used by the company in their City lighting. There are times, it may be, when the Weston lamps exhibited at the Palace burn unsteadily, but we must confess to have failed to see them at any such time, and apart from the time during which the carbons burn, we should be inclined to mention this lamp as one of the best in the market. We shall, however, now restrict ourselves more closely to the description of the machines than the lamps. As will be seen from the illustration, the pole pieces are joined to compound coils, six above and six below, connected in series. The current generated is passed through the coils, so that the Weston is a self-exciting machine. The armature revolves at a speed of about 900 revolutions per minute. The pole pieces are notched or serrated, instead of being, as is ordinarily the case, continuous, where they embrace the armature, and the edges separate slightly towards the centre. The curve, however, is very small. This construction is intended to provide for the gradual action of the inductive effect from the centre to the ends. The action will be better understood by means of the diagram (Fig. 6). Let the pole piece be represented by P P P P P, then any wire, say B, first leaves the pole piece at C, then gradually to C_1 C_{11}, the influence of the pole commencing from C_{11} C_1 C, and leaving from C C_1 C_{11}, and so on.

The armature is constructed of sectional plates of metal, shaped like open spur wheels (Fig. 7), with a washer between each plate, in such a manner that the space between each is

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opposite a similar slit or opening in the large iron electro-magnet, where they are not covered with the coils. There are thirty-six of these metal plates on the shaft, and at each

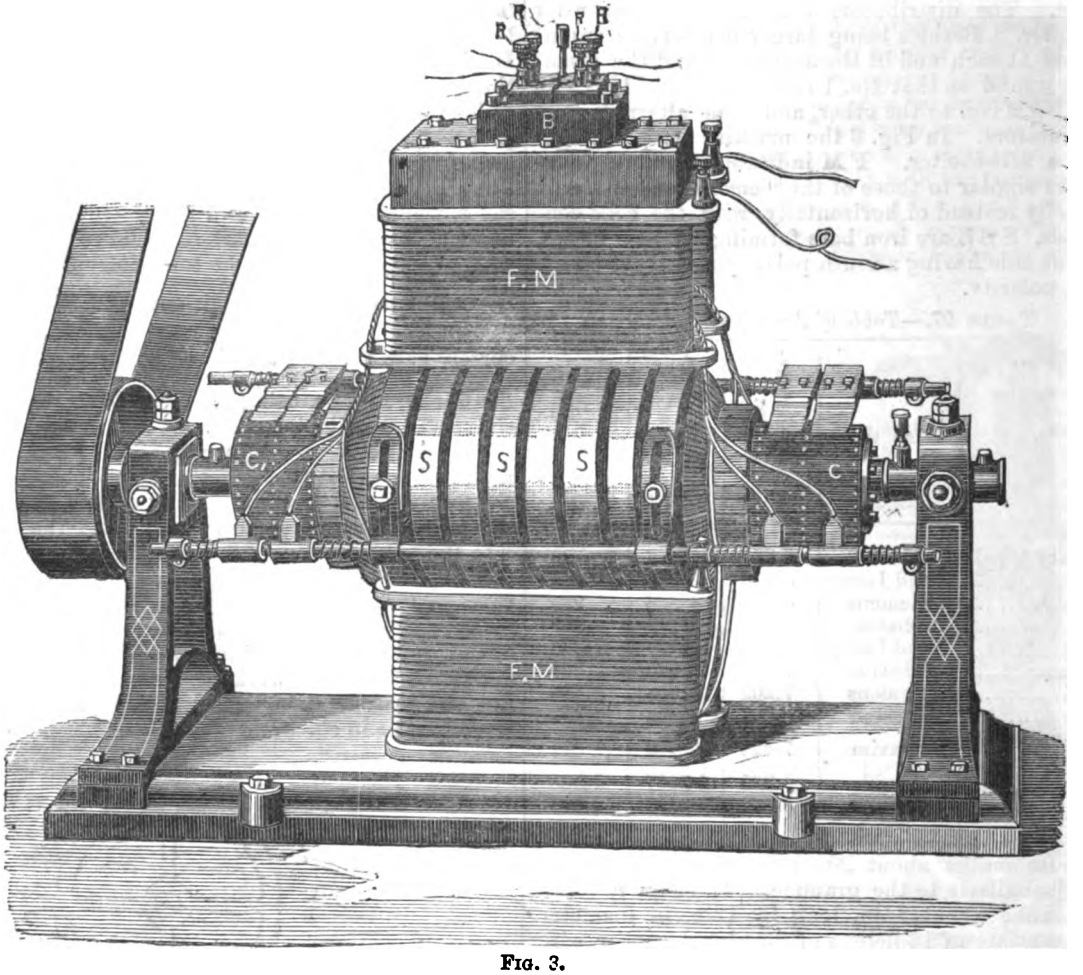

FIG. 3.

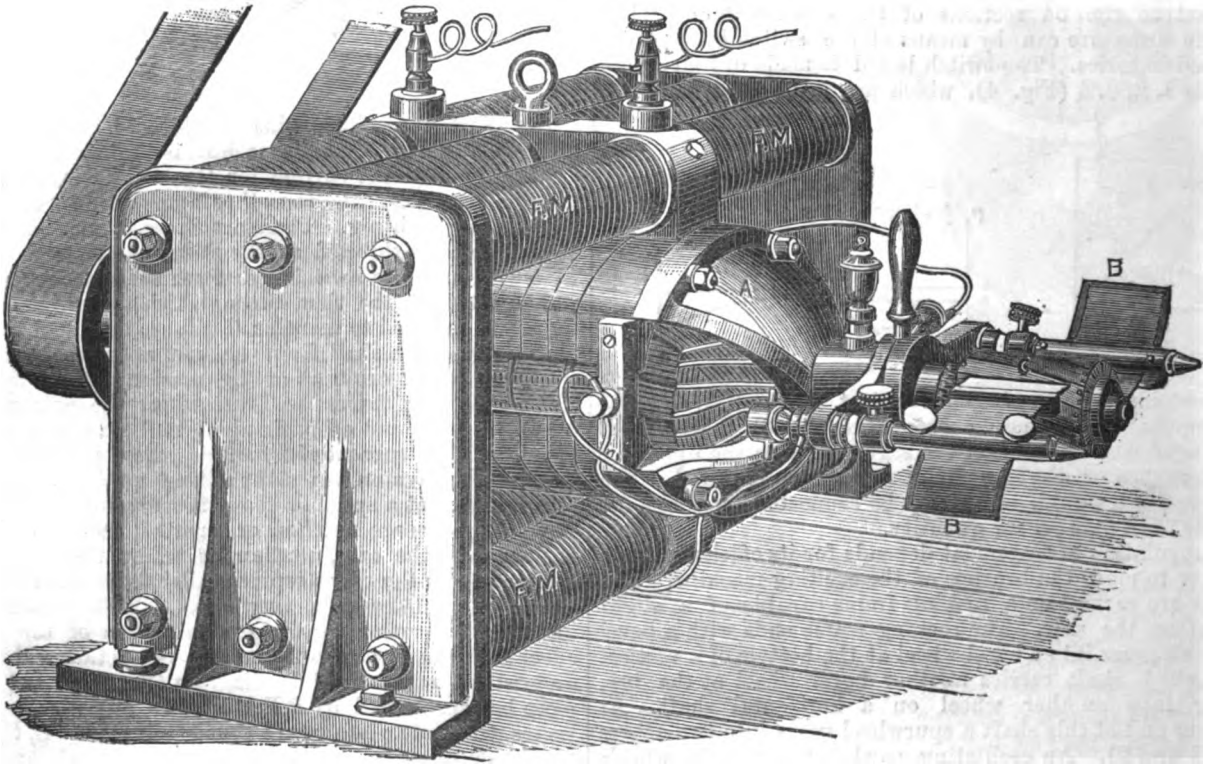

FIG. 5.

end a solid end piece, equal in diameter to that of the metal plate, measured across the bottoms of the notches. The wire is wound in the longitudinal grooves, the manner of winding being like that in the Siemens armature, that is, laid along one groove and brought back along the opposite groove. When in motion the current of air passes out of the slits, being propelled from the centre to the surface by the centrifugal tendency, on the same principle as the action of a rotary fan-blower. This continuous current of air, taken in

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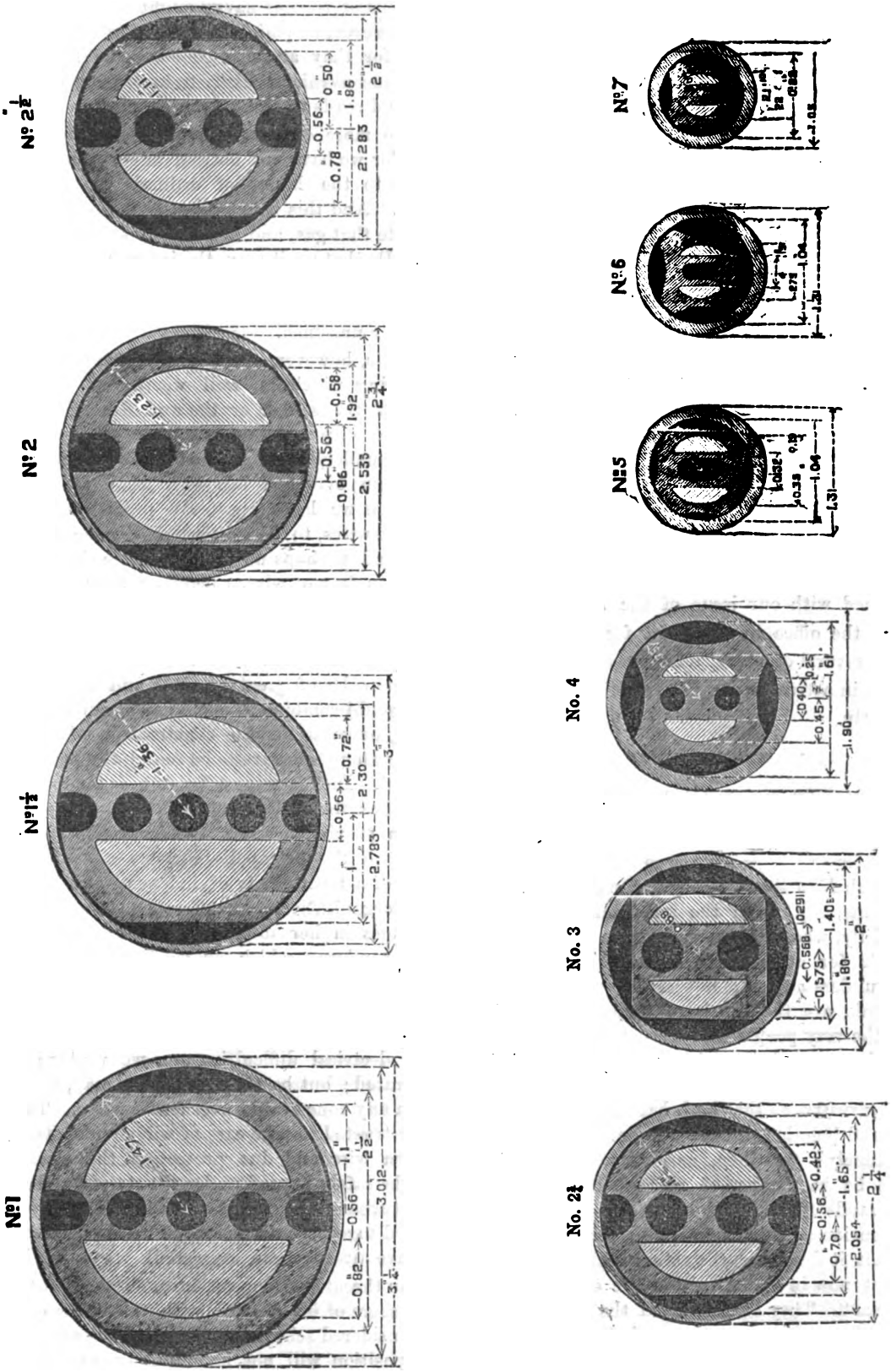
cool at the centre and blowing out at the circumference, is most effectual in keeping the machine cool, which, without this provision, loses much of its effectiveness, as the magnetic power of iron decreases when the temperature rises, and the conductivity of the coils for electric currents diminishes from the same cause. The commutator plates are arranged helically instead of, as usual, parallel with the axis of the shaft, and the brushes are thin curved plates of copper. The remaining exhibits of this company, which are of considerable importance, will be fully described and illustrated in a future number.

The Edison Light Mains.

We this week give illustrations of the conductors used by Mr. Edison for his street and house mains, as shown in his exhibit in the Entertainment Court at the Crystal Palace. The illustrations give the sizes of the various conductors, hence it will be needless for us to recapitulate them here.



SECTIONS OF EDISON'S STREET MAINS.

As will be understood, the conductors vary in size according to the current they are designed to carry. Two conductors of copper of half-moon section are inserted in iron tubes, being carefully insulated from each other, and from the containing tube.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

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NOTICE.—OUR SUPPLEMENT.

The supplement containing "Hints to Electric Light Engineers," published with our issue of the 7th January, can now be had at the office in pamphlet form, price one penny. In reply to several of our friends we may say that our next Supplement is in active preparation, and we hope to be able to issue it shortly.

THE RIGHT OF THE ROAD.

Of the many objections that have been made to the progress of electric lighting perhaps none is so curious and suggestive as that on behalf of the integrity of the roadway. If the outcry had come, say, from the inhabitants and frequenters of Piccadilly, who, it is stated, endure the pains of chronic road repair for at least six months out of every twelve, we could understand it; but seeing that the objectors, so to speak, are the repairers themselves, or, in other words, are the very people who respect the roadways least, we cannot all at once believe in the sincerity of their plea. It is true that if the zeal of one vestry overlapped the zeal of an adjoining vestry, so that both halves of a roadway were being renovated together, mutual recriminations would be natural and timely; for then, assuredly, the vestries themselves would be in danger of undergoing summary renovation at the hands of a blocked and exasperated public. Some such apprehension as this may account for, though we do not pretend that it describes, the actual attitude of the gas companies just now in assuming the *rôle* of the guardians of the pavement. They have enjoyed the privilege of making themselves a nuisance so long that every fresh competitor in that line of business may seem to imperil their immunity from opposition. And it must be owned that, what with imperfect drainage, insufficient water, and countless variety of experimental paving, to say nothing of pneumatic tubes and telegraph pipes, the risk is by no means imaginary. Still, it is one which is not peculiarly the concern of the corporations who supply gas to the community, unless, indeed, they are the chief offenders, which, to do them justice, is not generally the case. From one point of view, indeed, they might be supposed to welcome every fresh invasion of pickaxe, steam roller, or reeking asphalte, as so many diversions, under cover of which the comparatively inoffensive operations of the gas navvy might be conducted unobserved. This, however, is plainly not the view taken by the gas companies, for they are now amongst the foremost in pointing out the inconvenience likely to arise from molestation of foot paths and roads to make room for electric wires.

To be more exact we should have said electric lighting wires, for we have not noticed any objection from the same quarter to the laying of ordinary telegraph wires underground. And this being the case, it is easy for the scoffer to insinuate that gas, and not traffic, is the real object of solicitude. Be that as it may, the interest of gas proprietors are supposed to be threatened by the advent of electric lighting, and it is, therefore, impossible to regard their protests as altogether unselfish.

There is, however, one aspect of the question we are here considering which is well worthy of attention, whether raised by the selfish or the unselfish critic. The practical difficulties of carrying out a scheme of electric lighting with its wires underground are just beginning to be realised. To erect them overhead can only be a temporary expedient, doomed, as we have repeatedly predicted in respect to ærial telephone wires, to be compulsorily removed at considerable outlay, and perhaps no inconsiderable loss. This would be the certain fate of wires conveying the powerful currents for electric lighting purposes, and we hope it will not be heedlessly provoked.

Some general survey of the subways of our great towns would now be of great service; and if all the parties interested would combine to make use of suitable routes already existing, or even for the construction of fresh channels if need be where none are to be found, the problem would soon be solved. In this respect London is far from being so well provided as the capital city of France, or indeed as some of our own provincial cities, whose municipal government, unlike that of the metropolis, consists of a single organisation, instead of a multiplicity of independent and sometimes conflicting organisations. Yet London, to begin with, has some advantages in her underground railways, and her gigantic drainage subway, which no other place can boast of; and London it seems to us would be a good starting point for inaugurating a general scheme of underground electric cable laying.

The electrical difficulties are, we venture to say, greatly exaggerated; but be they what they may, they will speedily arise in any conceivable overhead system. The Government may be trusted to take care of wires under its control. With a return wire and due protection the electric-light wires would be safely housed under the streets, and would occasion no disturbance to telephone wires if they in turn were gathered together and insulated in any of the several ways that have already been suggested.

If the threatened opposition to electric lighting operations on the score of interference with the roadway result in some well-considered scheme of electrical subways, the motive for the opposition will not be minutely examined by the public at large. Unquestionably the unchecked and unregulated competition of new claimants for public custom would necessitate the taking up of roads to an extent not yet even dreamt of; and certainly the public has a right to be consulted in a matter of this kind. While, therefore, we cannot

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concede that the gas companies, any more than the water companies or the paving companies, have any prescriptive or exclusive rights in impeding locomotion, those rights, such as they are, are exercised with such inconvenient freedom already that nobody can desire to see their area enlarged or to confer them indiscriminately on every enterprising applicant. It is satisfactory to notice that the numerous Bills relating to electric lighting which are being submitted to Parliament this Session have induced the Government to take the subject in hand and deal with it comprehensively.

CORRESPONDENCE.

"WHAT IS ELECTRICITY?"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I now proceed to substantiate my proposition that the axes of the electric and magnetic forms of force are in the same plane, and, consequently, that the explanation hitherto received as to the cause of the movement of the galvanometer needle is incorrect.

To make this evident I must refer more at length than I have hitherto done in *The Electrician* to the direction of the lines of force, as I have traced them out by means of minute needle point test-magnets on the surface of and space immediately surrounding bar magnets.

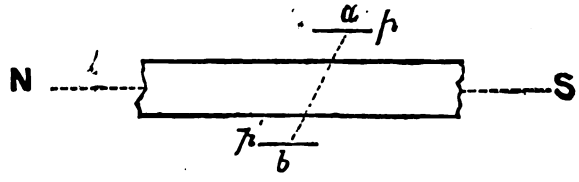

FIG. 1.

By reference to the diagrams the direction of these lines will be seen without difficulty. Fig. 3 represents a bar magnet 12in. long, over the surfaces of which I gummed white paper, and then traced out—with the aid of a hand lens and lines ruled 1-16th of an inch apart longitudinally, and other lines transversely—the direction of the force over every portion of each surface as indicated by the direction of the test magnet. With the exception of the lines dividing the surface transversely into spaces half an inch in length, the ruled lines do not appear, as they would only tend to confuse.

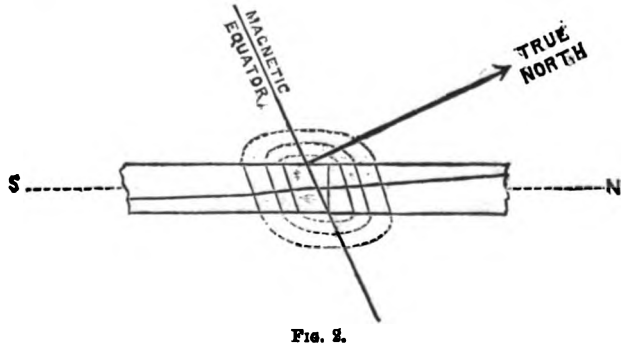

FIG. 2.

Fig. 1 shows the method I adopted in selecting the initial position of the extraneous curves, equidistant lines were drawn parallel to the bar, and a ¼in. test magnet—made from the middle portion of a very fine needle—was held over these lines, and when parallel to the bar magnet, the centre of such parallel lines was taken as the initial position from which to start equatorial curves such as *a b*, Fig. 1.

In every case the points of parallelism of the test needles in these equidistant lines upon being joined by a straight line, as shown by the dotted line Fig. 1, exhibited obliquity; but the principal obliquities were demonstrated by joining the points of contact with the bar of the curves fully traced out and shown in Fig. 2.

The obliquity of the equator on the surface of the bar was determined by suspending the ¼-inch test-magnet over the line marking the geometrical equator, and by subsequently tracing the lines towards the north and south poles by means of the ⅛ or 1-16 of inch test magnet needles.

An accurate delineation of the direction of the force over every surface of the bar was thus obtained, and is shown for one surface in Fig. 3.

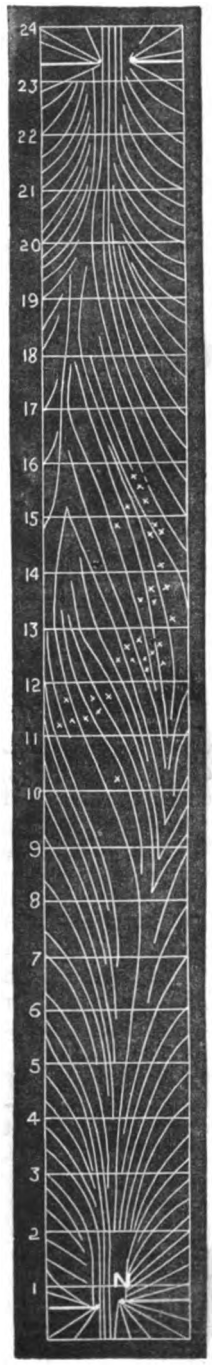

FIG. 3.

The true magnetic pole was found by holding a one-inch test-magnet—suspended from its equator in the same delicate manner—over the marked and unmarked surfaces near the ends of the bar, but without allowing it to touch the surface; or, by resting a ⅛ of an inch needle point test-magnet on the bar, the point where either became quite vertical was regarded as the true pole.

In Fig. 3 the two large white lines near either end of the bar, with a larger extremity, mark a line which I have since invariably found to traverse the bar from side to side—along which line the needle points take a rectangular direction to the axis of the bar—but in which direction the inclination or dip of the test-magnet increases from either side of the bar until at the centre or pole it takes a perpendicular position. The dots in the instance under observation mark two poles at either end of the bar, but upon re-examining the bar at this distance of time, I can only make one pole, and the lines are straight, as described across the bar end. Under any circumstances it will be observed that the lines from every point of the bar surface are directed to the pole proper, that they are oblique, and that the curvature increases as they approach the pole, whilst the degree of dip or inclination of the test magnet proves that the force is at all times moving under the influence of a lever as well as an inclined plane, a combination which is significant of helical force and which increases as the pole is approached.

Now, if we take the *coup d'œil* of the curves traced out from one end of the magnet to the other, we perceive that the axis of the bar cannot represent the axis of force, for the lines show that the force from every direction is moving to a given centre when all the momenta or vibrations coalesce to form a stream of force, which is the true axis of force as it is the resultant of the polygon of forces, the rectangular line round the bar making the same only in a less degree.

This fact is still further established when we scrutinise the direction in which force is applied when the bars are thrown into the magnetic condition. For if we magnetise a bar by rubbing it with the pole end of a magnet, we know that the force exists in the magnet in curved lines, and, therefore, that it must be impressed in lines of greater or lesser curvature, and from actual observation, as in Figs. 1, 2, and 3, we see what is the result of the impressed force upon the matter. Or, on the other hand, if we magnetise by means of a current of electricity, that current is moving in a helical direction round the bar, and the force originated in the bar must partake of the helical direction also, except in so far as it is interfered with by the matter of the bar in accordance with the second law of motion. Consequently, when a

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magnet is placed parallel to a wire conducting a current of electricity, *the force traversing the wire must cause a freely-suspended magnet to turn upon its axis, so as to place the axis of the force emanating from the pole, which is the sum of all the forces, in a plane parallel with the force moving in the wire.*

This condition of things is shown in Fig. 4. Let V C represent a wire which may or may not be traversed by a voltaic current, N S a magnet placed parallel to V C, and M F M F the axis of magnetic force. When a current of electricity is flowing through V C, M F M F must tend to rotate N S upon its axis; and if the current be sufficiently powerful N S will occupy the position marked for N′ S′ in dotted lines, and M F M F the lines indicated by M′ F′ M′ F′, and thus place the axes of the electric and magnetic conditions of force in parallel planes.

I next come to Proposition 3.

That the magnetic force is essentially a force moving in *helical* lines, and that the *closed* circuits of voltaic electricity to which Ampère attributed magnetism *do not* and cannot exist.

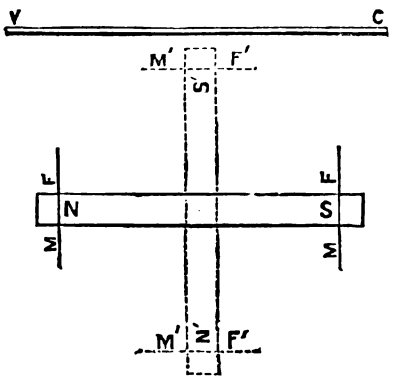

Fig. 4.

I have already shown that the force moves along the magnetic poles in the form of oblique lines or inclined planes, and that these lines are acted upon by leverage, the power of which increases in proportion to the curvature of the lines, and its proximity to the line marked M F in Fig. 4. I have also shown by direct experiment that when two similar poles are approached to each other, end on, and the test magnets are placed loosely point downwards on the edge of the fixed magnet, that they move by their free extremity in a *helicoidal* direction, turning to the right or left upwards in accordance with the relations they hold to the end of the bar upon which they are resting, and the end of the magnet moving towards them.

I am not aware that these movements can be explained by any other means than the application of force upon the principle of a lever and an inclined plane. They certainly do not accord with force acting in closed circuits if such could exist.

But we have abundant confirmatory evidence, first that the force is helical, and, secondly, that it does not exist in the *closed* circuits of voltaic electricity, the planes of which are *perpendicular* to the *axis of the filament* rendered magnetic, such as Ampère described; for if this were so the circuits could have neither a point of origin nor of termination, and I think I may add that any mathematician could prove such *closed* circuits of force are impossible.

The mode in which force is applied is a most important element in the study of mechanics, and when collating evidence in substantiation of my statement that the axes of the electric and magnetic conditions of force are in parallel planes, I drew particular attention to the mode in which force is applied for the production of artificial magnetism.

It will facilitate my object if I refer to some of the characteristics of the magnetic force. 1st. The momenta or vibrations which constitute electricity and magnetism may be transmitted through a fixed wire or magnet without the production of any visible motion of either body, although the momenta conveyed may originate motion in a third body, or even in the wire or magnet, if they are permitted freedom of movement. 2nd. In the case of two magnets there is no visible substance connecting the bodies between which the stress exists, hence the action between the magnets has usually been spoken of as *action at a distance.* 3rd. In no case is it possible to keep up a continuous rotation unless there be some *sliding or rolling contact;* for a single connected circuit can only expand to its greatest size—it cannot be adding lines of force indefinitely; hence, in all machines some moving contact is absolutely necessary.

What, then, is the effect of this sliding motion upon the body rotating? Certainly nothing less than a displacement laterally at the point of contact, and the displacement occurs in accordance with the second law of motion in the direction in which the force is impressed; consequently, the force during such double motion is impressed obliquely, and *continuity of motion is imparted at one and the same time with helical motion.*

But irrespective of the sliding contact, it is impossible to conceive a momentum being communicated along a given line of a rotating wheel, and that the momentum should make its exit from the wheel at the same point at which it was impressed, and motion of the wheel to be continued thereby; for the circuit having been completed, the momentum emerging and the momentum impressed must be equal, or nearly so, and no further force could be impressed at the same point to be productive of rotation.

In my next communication I shall hope to make it clear how the same principle of action is developed with the like results of continuity of motion in the earth.—Yours, &c.,

London-street, Reading. R. C. Sᴍᴇᴛᴛʟᴇ, M.D.

ELECTRICITY AND GAS *VERSUS* SMOKE.*

(Continued from page 190.*)*

Now I want to point out to you as quickly as I can the main lines on which we are to look for improvement in this matter of heating by gas. One of the most successful workers in this direction is that eminent electrical engineer, Dr. C. W. Siemens, President-elect of the British Association for the coming year. He has not only improved heating furnaces in detail, but he has introduced into practical operation a new and most important principle—the regenerative principle.

The fundamental idea of the regenerative process is to utilise the waste heat of a fire to warm the air and fuel with which that fire is supplied; so that, instead of feeding a fire with cold fuel and supplying it with cold air both of which have to be warmed up considerably before any combustion can take place, we can supply to the fire its fuel and air at a high temperature and ready to burn at once, without abstracting any effective heat from the fire; heating them simply at the expense of the waste heat which would otherwise go to warm the chimney or the universe in general, with no particular benefit to anybody. This fundamental idea can be applied in a variety of ways, which in principle may, I think, be reduced to three:

It may be done by convection alone;

It may be done by conduction alone; or

It may be done by a combination of convection and conduction.

When regeneration is carried on by convection alone some intermittent or reversing process is always necessary. It must be done by conveying the hot products of combustion through some chamber, by the walls of which the heat shall be abstracted and stored up, and the gases turned out fairly cool. When the chamber has become thoroughly heated the flow is to be stopped, and the air which feeds the fire is to be admitted in the reverse direction, through this same hot chamber, so as to abstract the heat stored up in its walls, and to reach the fire at a high temperature. As soon as the chamber has become appreciably cooled by this process the flow of air is to be stopped, and the products of combustion again admitted in the same direction as before, so as to warm the chamber up again, and beyond its original point, and so on alternately all day long. This operation is exactly what happens in the breathing apparatus of all animals. The higher forms of animal life have all a separate exit and entrance for their food, but none have a through passage for their breath. It is always pumped out the same way it went in, and generally through channels of some length, so that the regenerative operation may be effectively carried on. The heat of the expired breath is stored up in the windpipe and cavity of the mouth, or, still better, in the channels of the nose, and the

* A lecture delivered by Professor Oliver Lodge, partly at the London Institution and partly at St. George's Hall, Liverpool, in December, 1881.

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inspired air is warmed before it reaches the lungs by this (otherwise) waste heat. Anyone can feel the difference between breathing in the proper way, and breathing in through the nose and out through the mouth, or *vice versâ*; and if he continues the experiment on a cold day he will probably give himself a sore throat, if not bronchitis. One can also feel the coldness of the air by inhaling a quantity, with one's mouth wide open, too rapidly for it to become properly warmed. Delicate persons, as we know, extend their natural regenerative apparatus by passing their breath through a metal network, called a "respirator," and thus temper the inhaled air still more completely.

To adapt this to an ordinary furnace it is obviously necessary to provide a second chamber through which the products of combustion may pass while the air supply is flowing in through the first; and the intermittent reversing arrangement of the lungs must be changed into a double alternating arrangement, so that neither the air supply, nor the gas escape, may be ever interrupted.

This is exactly what Dr. Siemens has done. He has two precisely similar chambers with intricate fire-brick passages, with a reversing flap, which, after allowing the air to enter through one chamber, and the hot products of combustion to pass out through the other for a certain time, interchanges the currents, and makes the air pass in the opposite direction through the hotter chamber, and the hot gases to flow out through the cooler; the currents again to be interchanged and reversed after the lapse of an equal interval of time, and so on, the temperature gradually rising all the while. If, instead of solid coal, gaseous fuel is used, this, too, may be supplied to the fire red hot by means of another pair of chambers and another reversing flap. The set of four chambers, with double reversing apparatus, constitutes the Siemens regenerative gas furnace, and, after several reversals, the temperature of combustion can be raised nearly as high as the point of dissociation, the theoretic limit of a combustion temperature, and steel can be melted on the open hearth.

[A large diagram of the gas furnace lent by Dr. Siemens was exhibited.]

Regeneration by conduction (the second plan) is scarcely applicable to furnaces, but it has been applied to gas burners and to gas fires.

The regenerative gas burner on this principle is an argand, with a stout copper rod projecting up the middle of it, and terminating above the flame in a cup-shaped expansion, filled with fire-clay or other such material, while below the flame it is connected with a set of radial plates through which the air supplying the flame has to pass. The function of this rod is to conduct as much as possible of the waste heat of the flame downwards and there utilise it in warming the air, or both the air and gas, before they are allowed to mix and burn. By this means the temperature of the flame can be raised, and its light becomes brighter and whiter.

The regenerative gas fire has a copper or thick iron back, which similarly conducts some of the heat from the back of the fire, where it has very little effect in warming the room, down to some frill work or some parallel vertical plates, in between which the air supply passes and gets heated above the temperature of melting lead before it feeds the gas jets, of which a row are arranged along the bottom bar of the grate. This gas fire is becoming rather well known—it has been set up in many houses, and it is to be seen in the exhibition at South Kensington. Dr. Siemens recommends the use of coke or anthracite in combination with the gas, instead of the ordinary asbestos clinkers. By this means considerable economy can be attained. The coke burns away, it is true, but only slowly, and it is a cheap fuel. No smoke is given off, of course, and a very good and constant fire can be kept up with little trouble; but the real defects of any coke burning arrangement are, first, that more or less stoking must be done, and, secondly, that it does not do away with ash. This is why I do not admit that it is perfection, although it is cheap, it gives off no fumes into the room, and it is a great improvement on the ordinary wasteful ashy and smoky coal fire. Of course ash can be avoided by using clinkers, but then all the combustion has to be done by the gas; and at the present price of gas as supplied for illumination this is extravagant, except in exceptional cases.

Whether anthracite or coke will be used in connection with the gas fire of the future is an open question—probably at first, "Yes;" probably ultimately, "No." At first, "Yes," because the gas companies could not supply anything like gas enough with their present plant to cover an extended use for heating and cooking purposes; and, if they could, coke would become a drug in the market, and its cheapness would compel it to be used. Ultimately, "No," because I believe that when the public has learnt the advantages, the cleanliness, the convenience, and the labour-saving power of a gas fire pure and simple, they will not condescend to dilute these advantages by the use of any solid combustible, which requires to be carted to the house and put on by hand, even though the ash difficulty could be got over.

But you will say, "Must not coal gas be necessarily expensive? And to this I answer "No." It *is* expensive partly because the quantity consumed is not what it might be, partly because an illuminating gas is required and much purification is therefore necessary, and partly, also, because high profits are delighted in. Much of the purification, however, far more than pays itself, by the ammonia, the coal tar, and other products which are obtained; and I hope that the purification from sulphur will never be permitted greatly to relapse. Still, it is undeniable that a cruder gas for heating purposes could be supplied at a cheaper rate, even if the quantity supplied continued the same. But I look for a diminution in the price mainly to the greatly increased demand for gas which will set in as soon as it is used all day for heating and cooking on a large scale. The preservation of the mains and the interest on capital is no small portion of a gas works expenditure; and if six times the quantity of gas could be driven along the same mains, with the same or nearly the same capital outlay, the price per cubic foot could be greatly reduced.

Moreover, it is well known to gas manufacturers that for the first quarter of an hour after a charge of coal is pitched into the retorts, the gas emitted is very poor in illuminating power, and again, that towards the end of the process a feebly carbonised gas is given off for some hour, or hour-and-a-half. When, as at present, the whole of the gas, good and bad, is turned into one gas holder, its illuminating power is—say 16 candles—whereas if the middle portion of gas were turned into one retort, and the initial and final gas into another by some simple flap arrangement, a cheap gas for heating purposes would be obtained in the second holder, while from the first could be supplied a highly illuminating gas of over 20 candle-power. This is Dr. Siemens's proposal, to have two sets of holders and double mains, one for illuminating, the other for heating gas. It has, I believe been put to the test in Paris with excellent results.

Moreover, it is well known that coke from gas retorts is not so good as coke make specially without troubling about the quality of the gas evolved. Hence the manufacture of simply heating gas would result in a better quality of coke for smelting and other purposes. Again, the larger quantity of coal passing through the retorts would increase the supply of ammoniacal liquor, coal tar dyes, and other such products, and would stimulate the industries depending upon them.

But, for large furnace operations, gas made at a central station, and distributed in pipes, can hardly be used. It must be made on the spot, and for this purpose we have the Siemens gas producer, which will supply perfectly crude gas to be burnt in the furnace close at hand. And the great advantage of these gas retorts over the old ones is that a large quantity of the carbon itself is gasified into the form of carbonic oxide by the air passing over the red hot embers; and this gas, of good heating power, passes along with the ordinary hydro-carbons to be burnt.

Many, indeed, are the plans for producing carbonic oxide or other form of "air gas." Directly heating gas was seen to be wanted, various patents were taken out, and we have the Dowson gas and others. It is quite possible that the future use of coke will be, not to be put on the fire and burnt as coke, but to be turned into carbonic oxide, and burnt so.

The immense convenience of gaseous over solid fuel cannot fail to be appreciated before long.

But, you may say, if it comes to a question of cost, it *must* be cheaper to burn the coal directly, than it is first to make gas from it and then burn the gas. This I deny. As a matter of fact, you *must* make gas out of the coal—you do it whenever you put a fresh shovelful on the fire. The coal is vapourised at the expense of the heat of the fire, cooling it considerably, and a great deal of the gas so formed passes up the chimney before the temperature happens to get sufficiently high for some to ignite—especially as it is mixed with a good deal of carbonic acid from the burning mass below. The only question is, then, whether you will make the gas in this unscientific, accidental, and ignorant sort of way; or whether you will make it in a properly contrived vessel, which shall let none escape without being thoroughly burned. A great many well-contrived furnaces are, in fact, essentially gas retorts and furnaces combined. Minton's patent "ovens" for firing earthenware and china have a set of admirably contrived gas retorts built round the central dome, and it is the gas from these retorts that alone enters the chamber where the ware to be fired is stacked. By the proper adjustment, once for all, of the supply of air, all the gas and smoke is perfectly consumed, and nothing visible escapes into the atmosphere. And the best of it is that wherever such improved methods are adopted a very great economy results, amounting sometimes to as much as 50 or 60 per cent. The only fault I have to find with

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these and other admirable furnaces is that they do not utilise the waste heat to warm the incoming air, but they let it be supplied cold. Furnaces of this kind, however, are generally set down where coal is pretty cheap, and manufacturers prefer a slight extra cost to any increase in complexity, however small; and, as long they have the general run of rough British workmen to deal with, they are probably quite right. Still, that an economy in fuel would result in many furnaces from an application of the regenerative system in its third and simplest form is not to be doubted.

This third mode of applying the regenerative principle I have not yet spoken of, except to say that it might be regarded as a combination of the first two. In it the hot products of combustion are utilised to warm the incoming air without any accumulating chambers or reversing flaps. The hot gases are conveyed through a tube with highly conducting walls, outside which is the air to be warmed.

It was applied some time ago to the iron blast furnaces. These gigantic things used to have enormous flames playing over them, which represented pure waste, except in so far as they acted as ghastly and fitful lighthouses to the surrounding country. The hot gases are now led down by a large flue, and are burnt where they can warm the air supply which is being driven in in enormous volumes by the blast engines, and which when supplied cold exerted a great cooling effect near the bottom of the furnace.

A recent and beautiful application of this simple method of regeneration is the new gas burner of Frederick Siemens and Dr. Siemens, which is in operation at South Kensington and near the Holborn restaurant. In this magnificent light the gas burns round a central globe of porcelain, pierced at the top with a hole, down which all the products of combustion are automatically sucked. In passing down through a tube they warm, by conduction through its walls, the air and the gas which are rising unmixed in cylindrical cavities outside it to feed the flame. By this means the temperature of the flame is raised far above its ordinary value, and as a consequence a greatly increased quantity of light is obtained from the combustion of a given quantity of gas—a light, moreover, of a much whiter quality. It is most important to remember that whereas the *heat* to be obtained from the complete combustion of a given quantity of gas is a fixed and unalterable quantity, the *light* to be obtained is by no means so, but may vary from the no light of the laboratory Bunsen to the brilliant white of some recent burners.

If gas is to compete at all with the electric light, and I believe that for many years, if not for many centuries, it will so compete for some purposes—and, perhaps, strange to say, quite as much for outdoor lighting as for house illumination—a great improvement must take place, first in the quality of the gas (and this the simultaneous supply of heating gas will secure), and next in the mode of burning it. And improvements in the mode of burning it will certainly take the form of plans of raising the temperature of the flame as high as possible, so as to get the greatest possible amount of light out of it in proportion to the heat. Many modern burners have this effect (Sugg, Bray, &c.), and I am not concerned to praise one above another; I have only spoken specially about the Siemens burner because in it the regenerative principle is applied in a more obvious and complete manner than in some others; and because, also, it acts as an efficient ventilator, for it is combined with a flue which removes all the products of combustion. The unsightliness and the shadow of this flue are, however, two of the defects which remain to be removed.

A great deal more might be said on these matters, but my object is simply to show you that the question has been very carefully thought out, and to lead you to take an interest in it and study it for yourselves, which you can now so well do at the Smoke Abatement Exhibition. It is not an abstruse problem like some electrical ones are apt to be. Anyone can come to a pretty sound judgment on the matter; and the sooner gas shareholders understand it and take the matter up the better.

(TO BE CONTINUED.)

A CHEAP FORM OF VOLTAIC BATTERY.*

In these days of dynamo and magneto-electric machines and accumulators, voltaic batteries may seem old-fashioned and out of place, but they have, nevertheless, functions of their own, such as the supply of electricity for domestic purposes, for telegraphy and telephony, which possess sufficient importance to render any improvement or economy effected in their construction worthy of note. The author trusts that this consideration will be deemed a sufficient excuse for bringing before the Philosophical Society of Glasgow the details of a new and exceedingly cheap form of voltaic battery lately devised by him.

The object he had in view was to discover a combination capable of performing, at less cost, the duties at present so admirably fulfilled by the Leclanché battery. Although the new form has not yet undergone the crucial test of prolonged trial in actual service, yet for some months it has been subjected to severe tests side by side with the Leclanché, and has not shown any evidence of inferiority, either as regards power or durability.

The idea of the combination was suggested by the well-known fact that iron will not rust in solutions of the caustic alkalis, a fact probably due to the non-existence in such solutions of free oxygen and free carbonic acid. It was argued from this that if a plate of iron and a plate of zinc were immersed in such a solution, the iron, not being attackable by the alkali, would be strongly electro-negative to the zinc. Trial proved the idea to be strictly correct. Not only iron, but nickel and cobalt, as well as gold and silver, and the metals of the platinum group, were found to be practically as electro-negative to zinc as carbon itself. Carbon is at first a little more strongly electro-negative than iron; but, owing to the absorption of hydrogen in its pores, as soon as the circuit is closed, it is in practice in no wise superior. Silver is the most electro-negative of all the metals in the solutions. The use of iron, if practicable, has obviously several advantages. The cheapness of the metal, and its freedom from liability to fracture, as compared with carbon, are strong points in its favour, and it affords, besides, the possibility of making a perfect and permanent connection on the negative plate for the binding screw, an end so difficult to attain when carbon is used. It was discovered, however, that a simple iron plate polarised very rapidly, the hydrogen set free by the action of the battery clinging to it and greatly increasing the resistance. By surrounding the plate with a packing of small fragments of iron, such as clean turnings or borings, in the same manner as the carbon plate in the original type of Leclanché is surrounded by fragments of carbon and manganese dioxide, this deleterious action is considerably modified, and the cell acquires to a great extent the power of keeping up its electromotive force when working continuously through a low external resistance. The number of points presented by the turnings or borings is probably the cause of this, as it is well known that hydrogen escapes with much greater freedom from a rough, than from a smooth surface. The packing of iron fragments is, in fact, the platinised silver plate of Smee in another form. The greatest efficiency is obtained when the iron fragments are thoroughly damped by the solution, but not immersed in it, the obstacles to the escape of the hydrogen being then at their minimum. Although not quite constant when working through an external resistance of 20 ohms, the battery recovers its original electromotive force when allowed to rest with a rapidity sufficient to allow of its employment on the busiest telegraphic circuits, and for most other practical purposes. The electromotive force of the iron battery varies somewhat with the nature of the iron and the purity of the exciting salt employed; also with the degree to which the iron fragments are saturated or covered by the solution. The Daniell being 1, and the Leclanché, at its best, 1·30, the iron varies from 1·15 to 1·33. The last was an exceptionally good cell, and the average may be taken at 1·23, or ·07 less than the best Leclanché. But after working for some days continuously through a low external resistance, the iron keeps up its electromotive force much better than the Leclanché. This was proved lately, at the suggestion of Mr. David Graham, who thought it likely to demonstrate the comparative capacities of the two batteries for actual work, by setting a good specimen of each cell to ring an electro-magnetic trembling bell of precisely similar construction, and each of a resistance of 5 ohms, day and night, until they failed. They were started at 11:10 a.m. on the 23rd of December last. After four or five days the Leclanché became very weak, and, although it did not actually stop until January 12th, it latterly simply vibrated the hammer of the bell without striking the gong. The iron cell rang the bell powerfully until January 15th, and did not stop until January 23rd, exactly one month, or 744 hours from the date of starting.

The chemical reaction of the iron battery is probably as follows:—There being present when a solution of potassium hydroxide is used,

$$Zn_2 + K H O + H_2 O + Fe,$$

the closing of the circuit produces first

$$2 Zn O + K + H_3 + Fe.$$

That is to say, at the positive plate the oxygen of the potassium hydroxide and of the water is given off, and combines with two atoms of zinc to form zinc oxide. At the negative plate, the potassium and the hydrogen of the potassium hydroxide and the hydrogen of the water are set free. The metallic potassium instantly decomposes an additional molecule of water in the *negative* portion of the cell, with the oxygen of which and with one of the free atoms of hydrogen it combines to re-form potassium hydroxide, leaving the four atoms of hydrogen due to the decomposition of water free. This makes the final stage

$$2 Zn O + K H O + H_4 + Fe.$$

The caustic solution is, consequently, used up in the positive half of the battery, and re-formed in the negative. It is to the polarising action of the free hydrogen that the inconstancy of the eletromotive force is due. It, however, as has already been stated, ascends between the iron fragments and rapidly escapes to the air. The author has attempted in many different ways to get rid of this obnoxious gas, but without permanent success. Mixing platinum black with the iron packing answers to some extent for a time, as the platinum absorbs the gas, and leaves the iron free. Another plan is to place a chemical having a great affinity for oxygen, such as pyragellic acid, nitrate of cobalt, permanganate of potassium or sodium at the negative plate. But the chemicals which absorb oxygen with sufficient avidity have little permanency, and soon cease to act. The presence of a permanganate raises the electromotive force of the battery in addition to improving its constancy, but the effect is transient. A cell was placed in a jar of oxygen in hopes that this gas would find its way through the iron packing, and combine with the hydrogen to form water. But the hydrogen would have nothing to say to the oxygen until it was clear of the battery. It then combined, and, the cell, being kept at work, was in a couple of weeks drowned in water of its own creating. These are, however, at best complications, which, besides being superfluous, are inadmissable on the score of expense in a cheap battery, which the one under consideration is specially designed to be. Its cheapness and the ease with which it can be made up are, indeed, its most remarkable features. There is here an old tinned iron can, which, as the legend upon it distinctly states, was originally packed with corned beef in Chicago. At

* Paper read before the Philosophical Society of Glasgow on February 1st by Mr. Alfred R. Bennett, M.S.T.E. and E., engineer to Messrs. D. and G. Graham, Glasgow.

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that time there was little probability, it is to be presumed, of its making its appearance before such a learned assembly as the present. The beef having been consumed in Glasgow by some of Her Majesty's lieges now unknown, the can was cast aside as useless, and was acquired without much difficulty or prolonged negotiation by the firm of Messrs. D. and G. Graham for the sum of one farthing sterling. There is also here a quantity of iron borings swept from the floor of an engineer's workshop, the cost being simply the time and trouble consumed in sweeping. There is also a strip of common zinc, cut from an old roof ventilator; a porous cell, and a bottle containing a solution of 4oz. of commercial potassium hydroxide. The porous cell being placed in the tinned iron can, and packed with borings, the solution is poured in, and the zinc strip immersed in it. The ends of an electric bell circuit being attached to the can and the zinc strip, the fact that a powerful current has already been set up is made sufficiently obvious [Experiment shown.]. After a few minutes it will become still more powerful; and if left to itself the cell would ring the bell night and day for at least three weeks without any noticeable loss of energy.

The differences of electromotive force or capacity for outside work of the various types of batteries may be roughly shown in the following manner: Here is a Daniell cell joined through a box of resistance coils, and an electro-magnetic trembling bell of 5 ohms' resistance. Through no resistance but its own and that of the bell it makes a considerable noise, but by gradually introducing resistance this is diminished until, when 22 ohms have been plugged out, the hammer is vibrated without striking the gong. This effect is produced through five ohms, its own internal resistance; five ohms, the resistance of the bell; and 22 ohms inserted resistance—a total of 32 ohms. Taking an iron cell instead of a Daniell to bring about a similar state of affairs, 35 ohms have to be plugged out, which, with five for the bell and one for its own internal resistance, makes a total of 41. Substituting a Leclanché, one additional ohm is needed, or a total of 42. With an iron cell super-excited with permanganate of potash, no less than 50 ohms, or a total of 56, must be plugged out before the hammer ceases to strike the gong. The electromotive forces of the four cells are then in the proportions—1, 1·28, 1·31, 1·75. In volts, these figures become—1·079, 1·381, 1·413, 1·888. This method corresponds to the reproduction of a constant deflection on a galvanometer. It is not to be commended for strict accuracy, but by its means it is possible to demonstrate to an audience facts which otherwise could only be referred to verbally. The results, too, are substantially correct, agreeing well with observations made with far more delicate instruments.

(TO BE CONTINUED.)

LECTURES AT THE CRYSTAL PALACE.

OPENING LECTURE.

Professor Sylvanus Thompson, of Bristol, lectured on Wednesday night at the Crystal Palace on "Electric Currents: What are they?" This lecture, the first of a series which the directors of the Palace have organised in connection with the International Exhibition of Electricity, was delivered in the concert-room.

The lecturer began with an enumeration of the multifarious services now rendered to mankind by the electric current, such as the ringing of bells, the giving of signals, the transmission of messages by telegraph, and the giving of light. Yet, though its applications were endless, it was remarkable how little was known of its intimate nature. To understand the true nature of electric currents, or even of electricity itself, necessitated a wide range of study, the more careful because of the great variety in the different properties and phenomena. Electricity might remain in the form of "charges" on the surface of bodies, or might flow through their substance in continuous "currents." Yet it was not a material fluid, and the term "electric fluid" was now only used by those who knew nothing about modern investigations in the science. Nevertheless, a study of the various properties of electricity, the attractions and repulsions it set up, the sparks to which it gave rise, the chemical decompositions it effected, the magnetic actions it produced, all led toward a certain theory, only to be grasped when all these diverging lines were traced back to their logical origin. It was a matter of congratulation that so many eager and able scientific men were now devoting themselves to this youngest of the sciences, more especially as it was pre-eminently a British science. Almost every great discovery in electricity had been made by Englishmen. From the time of Dr. Gilbert, who founded the science in 1600, Englishmen had been foremost in electric discovery. Boyle, Hawksbee, Sir Isaac Newton, were among the foremost investigators. Stephen Grey discovered that electricity could be made to flow in currents through wires; John Canton discovered the influence exerted by electricity at a distance; Benjamin Franklin, the inventor of the lightning rod, was a Briton, though resident then in Philadelphia; Humphrey Davy, the discoverer of the electric light; Spencer, the inventor of electro-plating; Faraday, the greatest experimentalist in electric science that ever lived, to whose fundamental discoveries modern dynamo-electric machinery may be directly traced; Ronalds, Cooke, and Wheatstone, the fathers of the electric telegraph, and Swan, the inventor of the carbon-filament lamp, were all Englishmen, while Graham Bell, the perfecter of the telephone, was Briton-born. Not that some great discoveries had not come from other lands. Cunæus, a Dutchman, discovered the Leyden jar; Volta, an Italian, discovered the Voltaic cell; Oersted, a Dane, discovered the relation between magnets and electric currents; Reis, a German, invented the first rude telephone by which articulate speech was transmitted; and Planté, a Frenchman, invented the storage-battery or accumulator. Professor Thompson described the production of electricity by means of friction, showing the action not only of frictional machines, but of machines on the inductive principle. He pointed out the gradual development of voltaic electricity, from Volta's pile to Daniell's, Groves' and Bunsen's cells, at the same time directing attention to the costly method of producing the current by the consumption of zinc. As an illustration he explained the theoretic work obtained by the consumption of 1oz. of various kinds of fuel, thus:—

1oz. of Coal gives	.....	695,000	foot-pounds.
,, Gunpowder gives	.....	100,000	,, ,,
,, Zinc gives	.....	113,000	,, ,,
,, Copper gives	.....	69,000	,, ,,
,, Hydrogen gives	.....	2,925,000	,, ,,

After thus referring to the relation between the power of electric currents and the power that is spent in producing them, Professor Thompson spoke of the certainty that in the near future all heavy mechanical work would be done by electric currents in the place of steam, a theme which will claim further attention in a subsequent lecture. Developing the question of the production of electric currents in voltaic batteries, the lecturer referred to the discovery that such batteries were reversible, and that in this reversibility lay the newly-discovered power of storing or accumulating electric energy in cells which could be charged and discharged at pleasure. The magnetic and thermal properties of the electric current were illustrated experimentally, the lecturer remarking, with much emphasis, about the physiological properties that the mistake of confounding these with medical or remedial effects led to the gross impositions of the quacks and rogues who deal in so-called magnetic appliances, and disgrace alike the sciences of electricity and of medicine, while knowing nothing of either. The nature of electric currents was reverted to, and an outline was given of the theory of Clerk Maxwell that all electric phenomena were due to actions going on in the thin medium that fills the whole universe—the *æther*—vibrations of which are light and heat, the accumulations of which are electric charges, the streams in which are electric currents, and which, where it was made to spin round in vortices or whirlpools, gave rise to magnetic attractions. In conclusion, the lecturer commented on the immense importance of the revolution now beginning in the substitution of electric machinery for steam engines, and urged that if England desired to reap the benefit of this impending reorganisation of the methods of mechanical production, if she desired that her workmen should rise to the immense future before them, she must not lose an hour in providing them with an education in matters electrical, seeing that a knowledge of electric currents and their properties will be of far more practical importance than a knowledge of any other branch of science. If technical education did not come in any other way, it would be forced upon us by the practical fact that electricity is to be our servant in the place of steam and of coal.

OPENING OF THE CALCUTTA TELEPHONE EXCHANGE.

The *Calcutta Englishman* for the 30th January contains a long account of the opening of the Oriental Telephone Company's Indian Exchanges on the 28th of that month, by Major the Hon. E. Baring, from which we make the following extracts:—

Our contemporary, after giving a list of the notabilities present at the opening ceremony, says:—"The 'Exchange' (at Calcutta) is situated at 7, Council House-street, and Mr. Clement Davidson Legatt, the representative in Ceylon and India of the Oriental Telephone Company, and the Agents of the Company in Calcutta, Messrs. Carlisle Nephews, received Major Baring on his arrival at the entrance to the Exchange and conducted him to the 'central switch room,' where all the guests were assembled. The telephone was then successively connected with the *Englishman* Press Office, Messrs. Carlisle Nephews, Spence's Hotel, the Great Eastern Hotel, and several other offices, and the speaking power of this extraordinary instrument was tested without the slightest interruption, manifesting the extraordinary rapidity with which 'the connections were formed' and conversation carried on."

Speeches were then made by Mr. Legatt, thanking Major Baring for his kindness in being present that day to open the Exchange, and by Major Baring, in which he referred to the progress made by the telephone in London and elsewhere. Speaking of the difficulties encountered by the Oriental Telephone Company in introducing the telephone into India, Major Baring said:—"Before this Company commenced its operations in India, some difficulties, no doubt, had to be encountered; but those difficulties, I venture to think, were no greater than were to be expected in the inception of an enterprise of so novel a character. If those difficulties have been overcome, the credit is mainly due to my honourable friend and colleague, Mr. Gibbs, who presides over the Public Works Department, and who has throughout conducted the negotiations with the Telephone Company in a spirit of friendly and sympathetic interest." Subsequently, Major Baring signed and despatched telegrams to Madras and Bombay, declaring the Companies Exchanges in those cities open, and to Mr. Pender in London, as chairman of the Company, congratulating the directors on the successful inauguration of their work in India. This closed the proceedings.

In describing the technical arrangements of the Calcutta Exchange, our contemporary says:—

"We may begin by stating that the system being introduced into Calcutta, and also, we believe, in Bombay, Madras, and Rangoon, is that known as the Law system, in contradistinction to the magneto system which is in vogue in most of the principal cities in Europe. This system, so called from its general adoption in America by all the legal profession, has been universally conceded to be a system uniting great speed in connection with a minimum of trouble to subscribers in intimating their wishes. In the Calcutta Telephone Exchange the wires dispersed throughout the city to the offices and residences of subscribers, converge on the roof of the central office, where they are supported on a substantial framework of iron, which, however, offers very slight surface to the wind. This desideratum has evidently been throughout kept in mind by the constructing engineer on account of the high winds prevailing in Calcutta during certain seasons of the year. From this point the wires are now projected beyond the balustrading by a continuation of the framework to a point lower down, when they terminate on longitudinal iron bracket work. The wires are now led into the operating room in perfect order, and again finish off on the row of lightning arresters, which offer a ready and effective passage through numerous points to dead earth, whenever any electrical discharge of high potential should take place. The ornamental effect of the inside arrangement now commences. The office wires are led up from the arresters through cleated supports to the ceiling of the operating room, when, after meeting at mathematical angles, they meet and together descend to the back of the switch boards, where they are lost to view. The switch boards are mounted upon an erection of wood work, which is rigidly held in place by six iron pillars, fixed to the ceiling. The whole is surmounted by an ornamental moulding. The three switch boards themselves consist of 75

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longitudinal connection strips running the entire length, and entirely disconnected from each other. Just below this is projected a small table supporting the 300 private lines of subscribers which terminate in a weighted cord and plug. The system is now simplicity itself. The operator, upon receiving a call by the telephone, which is always in circuit on a call wire, merely takes up the two plugs of the two lines and connects them to one strip, touching them both before connection to a battery strip, thus giving the signal to both parties at once."

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).

The ninth ordinary general meeting of this Company was held on Friday, Feb. 17, at the Cannon-street Hotel, Mr. John Pender, M.P., in the chair.

Mr. J. W. FULLER (the secretary and traffic manager) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, you have had the report in your hands for some time. I presume you will take it as read [agreed to]. Gentlemen, before asking you to adopt the report I shall, as usual, give you a few of the figures to show the variations that have occurred during the last six months. As shown by the report, the revenue for the half year to the 31st December last, after deducting out payments, amounted to £64,514, and the working and other expenses, including interest on debentures and income-tax, were £25,574, leaving a balance of £38,939 as the profit of the half year, making, with £7,179 brought from the previous half year, a total of £46,119. This amount has been appropriated in the following manner:—Interim dividend of 5s. per share, to 30th September, £15,177: interim dividend of 5s. per share, to 31st December, £15,177; amount set aside to reserve fund, £11,141; balance carried forward, £4,623—making a total of £46,119. The half year's revenue shows an increase of about £4,700 over that for the corresponding period of 1880. Owing, however, to the various tariffs in operation during the two half years, no reliable comparison of the receipts can be made; but I shall refer later to the 1s. tariff, which has been in operation since the 1st of August. Passing on to the expenditure, it will be seen that although on the whole we have spent less than in the corresponding period of 1880, there are certain items of the working charges which show an increase. Regarding these increases, the item of salaries, wages, house allowances, &c., stands first for £1,016 additional. The increased number of hours during which the duplex system is now worked daily on the main cable as compared with the time it was employed when the system was first adopted, also its recent application to the short cable, have rendered necessary the employment of an increased staff, and this fact is mainly accountable for the extra outlay. The additional cost of travelling expenses by some £194 was incurred by the cost of despatching the extra clerks to their respective stations. The item printing, stationery, and advertising is £187 more than in the corresponding period of 1880, and is wholly attributable to the increased consumption of message forms and other stationery through the low tariff. The remaining items show but little variation as compared with December, 1880, and, therefore, call for no remark. As shown by the accounts, the reserve fund now amounts to a quarter of a million sterling, and the Company's investments remain the same as at the previous half year. The interest on the Company's investments now amounts to about £10,000 per annum. Gentlemen, these figures, as far as they go, show you satisfactorily and exactly the reason for the small increased expenditure. Now, gentlemen, on an occasion like the present, I think it is well that almost every word that I give utterance to should be carefully and well considered; I have, therefore, looking to the position which we now occupy, and to the competition which may shortly arise, thought it right that I should give the shareholders as much information as it is desirable that they should possess, and which we are anxious should be given them, so that they may act in perfect concert with the directors. Having given you the figures showing the working of our system for the last six months, it may be interesting to you, before putting the resolution, if I give you a little information as to the present position and the prospects of this Company. Let me first congratulate you upon the fact, and a very important fact it is, that during the past year we have not had any interruption of our cables, and that at the present moment they are in perfect working order. When I had the pleasure of addressing you six months ago, I went very fully into the subject of the position which the English submarine cables held, and the advantages which they had conferred upon the telegraphing public. I contrasted the liberal policy which they had adopted in the reduction of rates to the policy pursued by the land system in America since it had come under new management, and I have nothing further to add to what I then said. But I think it will interest you if I give you some information as to the effect which the one shilling tariff has had upon our receipts. When I referred to the threatened Gould company competition six months ago, it was said that one cable was aid and another cable was in course of being laid. The new company did, as a matter of fact, open in September last with a tariff of 1s. 6d. per word as against our 1s. tariff; but their cable only worked for a few days, and, if I am rightly informed, in attempting to repair the second cable, which was broken in course of laying, they cut through their first cable, consequently at the present moment their cables are not yet completed. But assuming that they will soon have their cables in working order, then will come the competition; but if the Western Union Company fulfil their contract obligations to the existing Atlantic companies, there ought to be no question as to the strength of our position. If, on the other hand, those obligations are departed from, and the Western Union Company divert traffic due to the old companies to the Gould company's cables, the competition may prove not only severe, but the question of our rights will require to be decided by legal means. It has been rumoured that the existing contracts between the Anglo Company, the Western Union, and other companies may be disturbed, but I may say I consider those contracts legally maintainable, and if broken, would involve a very large sum of money for damages, and of course we shall be guided by legal advice as to the best means of protecting our interests. I am, however, hopeful that, having regard to the fact that one of the directors of the Anglo-American Company has now become a Director of the Western Union Company, that those obligations, which are binding legally and morally, will be honourably fulfilled, especially as he was a party to those contracts which were made between the Anglo and Western Union companies in the early days of Atlantic submarine telegraphy. I think I have afforded you sufficient information on this point, and it would be inexpedient to go further into this question, which may possibly require to be dealt with judicially. Now, as to the question of the one shilling tariff. In my last address to you I stated that we had not adopted the one shilling tariff merely as a "fighting" tariff, but that I believed it would be an enormous boon to the telegraphing public, and it was anticipated that the increase in the traffic would more than compensate for the loss which we should sustain by the reduced rate. I have only to say that we have so far been disappointed in this anticipation; but when we consider that the one shilling tariff in 1877 only yielded £870 per day, and that now it is yielding about £1,670 per day, it shows us that it has taken about five years to develope it to that extent. Believing as I do that there is still an enormous development in submarine telegraphy, still I think we can scarcely expect that it will be more rapid in the next five years than it has been in the last five years, consequently it may take at least from four to five years to produce the same revenue under the 1s. rate as we were earning under the 2s. rate. The next thing which I dare say it will interest you to know, and which I should also like the public to know, is this—that had we not duplexed our cables, it would have been quite impossible to have transmitted the traffic which we now have to carry at the one shilling rate, without additional cables. The duplex system costs the different companies under £8,000 per annum, giving us about the same carrying capacity as five new cables, which would have cost in interest alone from £200,000 to £250,000 per annum. It is, therefore, clear that alone enabled us to make the trial with a shilling rate; but with all these advantages I doubt if we shall be able to do the amount of work under a shilling tariff to make up the amount which was being earned under the 2s. tariff. But that you may fully understand this point, I may say that we could do this work, and have a considerable margin, provided we could keep our cables full for twenty-four hours a day throughout the whole year; but as the important part of our business is confined to, say, about sixteen hours in the twenty-four, and as the average of our cables in use may be said (taking into account breakages and interruptions) to be five, instead of six, I am bound to admit that I am not sanguine of the 1s. rate proving satisfactory to the shareholders—that is to say, if we are to put by a sufficient sum to reserve, which I believe is an absolute necessity for maintaining our system. The reserve should accumulate to a sum equal at least to that which we have hitherto set aside for that purpose, and I have no hesitation in saying that, looking to the fact that Atlantic cable property at the present moment stands in the market at 50 per cent. discount, unless we are prepared, by means of such a reserve fund, to replace our cable when it shall be worn out, it would be impossible to obtain money from the public to replace that cable, unless, to speak in plain language, we paid two prices for it. Gentlemen, you will, I believe, agree with me that we must go upon the principle of making the existing cables pay for their own replacement. These are plain statements, not, you will say, very sanguine as to the position of submarine telegraphs; but yet, in the face of this uncertainty of telegraph property, there has never been any want of persons who seem to be attracted to it. It is quite true that there are existing manufacturing companies who will, of course, endeavour to keep their wheels running, and also parties who will find some good excuse for promoting this particular enterprise, but I think it well to state plainly that any one who may lay cables to compete with the present system at a one shilling tariff will find that, in the first place, their property will immediately be depreciated 50 per cent., and that the return upon the original capital will, if a reserve is to be put aside, barely pay working expenses, even if they have traffic to fill their cables; so that I cannot conceive that we are likely, at all events for some time to come, to have new companies springing up to lay cables in the Atlantic, but when the two new competing cables come into operation, and they get their full share of the traffic, which we assume that they may get unless there should be a development in traffic equal to what they take from us, then the decrease in revenue, which is now 33 per cent., may become to the existing companies 50 per cent. You will, therefore, see that we have a decrease in revenue and an increase in expense, as the additional words to be carried require extra staff. But that you may understand exactly what the 1s. tariff is earning at present, and how it is likely to influence our dividends in future, I may mention that the combined companies were earning something like £900,000 per annum at the 2s. rate, but at the 1s. rate we have been earning during the last six months, only at the rate of £600,000 per annum. The fact is, we require to carry a further 66 per cent. increase upon the number of words carried under two shilling tariff to make up the present revenue to what it was under that tariff; and for the reasons I have given it is doubtful whether the combined companies could do it, taking into account the various interruptions and limited hours in which this business has to be carried or dealt with. I am quite sure you will not ask me to say anything further on this subject at the present moment. We have given you all the information we possess ourselves. We think it would be wrong to know anything that would be detrimental to your interests without putting it plainly before you. I have done that to-day, and you must now form your own judgment. While we continue to manage your affairs, we shall do it in your interests as far as our judgment and our ability enable us to do so, and I trust, with the experience which we have had in managing submarine telegraph property, it will enable us, at all events, to place you in the best position that you can be placed in, during any competition that may arise, and it will always be our consideration—our first consideration—to secure under all circumstances the best dividend that we can for our shareholders. With these remarks I beg to move the resolution, "That the report of the directors, dated the 8th day of February, 1882, together with the statement of accounts annexed thereto, be, and the same are hereby adopted."

Mr. WILLIAM FORD: I beg to second that.

The CHAIRMAN: Now, gentlemen, the resolution having been moved and seconded, if any gentleman has any remark to make I shall be happy to listen to him, or to answer any question.

As no shareholder rose to address the meeting or to ask any question,

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the CHAIRMAN put the motion for the adoption of the report, which was carried unanimously.

Mr. JOHN NEWTON: I beg to move a vote of thanks to the chairman and directors for the information which has been given us to-day. The information has been as full and complete as we could possibly expect from the board of directors. I have very great pleasure in moving a vote of thanks to the chairman and directors.

Mr. SEGELCKE seconded the motion, which was put and carried unanimously.

The CHAIRMAN: Gentlemen, I thank you for your confidence, and I think that as there have been no remarks upon the statement which I have made that you all sympathise with us. We feel that our strength as directors is in having the complete confidence and support of the shareholders. We thank you for the confidence you have placed in us.

The proceedings then terminated.

SUBMARINE TELEGRAPH COMPANY.

The ordinary half-yearly general meeting of the proprietors of this Company was held on the 22nd inst., at the offices, Throgmorton-avenue, under the presidency of Sir James Carmichael, Bart.

The SECRETARY (Mr. E. M. Clare) having read the notice convening the meeting, the report was taken as read. It stated that the accounts for the six months ending 31st December, 1881, showed a balance of profit which enabled the directors to add the usual proportion of the gross receipts to the reserve fund, and to recommend a dividend at the rate of 19 per cent. per annum. The statement of joint earnings showed that the amount received during the half year had been £69,452.

The CHAIRMAN, in the course of his remarks in moving the adoption of the report and accounts, said: I have great pleasure in calling your attention to the very satisfactory—I think you will agree it is satisfactory—increase of traffic we have had which has enabled us to recommend to you to-day to pay a dividend at the rate of 19 per cent. per annum, to place £5,777 to reserve fund, and to carry over a balance of £709. Besides that we have also placed to reserve for our steamer £227, to eventually extinguish our account for that, so that, in fact, the total reserve fund at present is £100,486. I think that that is a very satisfactory position for this Company to be in. That includes the cost of this building, which I look on as a most valuable asset. No doubt you have been lately alarmed at what has appeared in various papers. You have seen statements about the gales of wind, and the number of cables that we have had broken; but, practically speaking, we have not spent more than usual for damages to our cables. You see that the total cost for the repairs in the last six months has not been heavier than usual. It is quite true that at one time we had no less than six cables broken simultaneously; but such a thing has never occurred before in the history of the Company, and I think it reflects very great credit on our engineer, Mr. Bourdeaux, because in eight days he had three of the cables put through—two in the English Channel and one in the North Sea. Perhaps you would like to know how much new cable he used in repairing those three cables. We have always a store of old cable, which we pick up and repair and lay down again, and we only used a little over two miles of new cable in these repairs. I think, as I have said, that that reflects great credit on your engineer. Then, again, with regard to the great delays mentioned in the newspapers in consequence of the damages and injury to the cables I think if you look into the question you will find that those delays were occasioned as much, if not more, by accidents to the land lines. The same storm that affects a cable is sure to knock down certain posts and injure the land lines, and we find that they are not so prompt in repairing the land lines as we are in repairing cables. Thus at one time there was only one wire to take messages between Boulogne and Dover. The same thing happened at Havre and at Beechy Head. There has also been a memorial sent to the Board of Trade by gentlemen of influence in the telegraph world, and they have £27,000,000 at the bottom of the sea. I hope it is not all at the bottom of the sea, and I don't think so. They seem to think that fresh legislation is required to protect their property from ships' anchors and fishing boats, and that no one is to have a right to the bottom of the sea except the cable companies. I am not of that opinion, however, and I think any penal or harsh legislation might do great harm. There is one thing I am very desirous to be protected from, and we have been in communication with Her Majesty's Postmaster-General and Lord Granville of the Foreign Office on the subject, and that is to see some very distinct system of signals adopted by all steamers engaged in the repairing or the laying of cables. If we had a good system of signals by which every steamer was distinguishable, and some international law was passed compelling all fishing craft in setting their nets and so on to give a wide berth to those steamers I think that that would be fair. I think that John Bull would complain quite as much of interference with fishing boats which deprived him of his fish as he might complain in respect to interference with cables. I don't think it would be wise to press this matter too far; and so with ships' anchors, I don't think it possible to say that a ship shall not anchor in a particular position, because a cable is there; but with proper care if she hooks a cable she can disconnect it and lay the cable again. If not, and there is any wilful and malicious injury done, we can recover damages. That we have proved in the case of the "Clara Killan." We occasionally have some little difficulties with the fishermen, but we settle them in an amicable manner. He then expressed regret at the death of their late colleague, Mr. Saunderson, and stated that the Right Hon. Robert Bourke, M.P., had offered himself for the vacant seat. After referring to the qualifications of the right hon. gentleman for the position, he alluded to the distress which had befallen Mr. Jacob Brett, whose brother was formerly an old director and one of the founders of the Company, and expressed a hope that they would render some assistance to Mr. Brett. He concluded by apologising for the absence of Sir Julian Goldsmid, who was in the South of France.

Mr. FORD seconded the motion, and stated that the signals formerly laid down by the Board of Admiralty for cable ships were right and proper, but those at present in use by direction of the Board of Trade were quite useless and mischievous.

The motion was carried unanimously, and the dividend recommended was afterwards declared.

On the motion of the chairman, seconded by the Hon. Ashley Ponsonby, the Right Hon. Robert Bourke was elected a director, and a resolution voting £200 towards the fund proposed to be raised to Mr. Jacob Brett was afterwards passed, on the motion of Mr. Ford, seconded by Mr. Boys.

Sir ARTHUR OTWAY (director) pointed out *apropos* of the contribution towards the fund to Mr. Brett that a gentleman who claimed to be the pioneer of submarine telegraphy had no right to that claim, and that it belonged solely to this Company and its *employés*.

A vote of thanks to the chairman and directors terminated the proceedings.

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY (LIMITED).

The 49th ordinary general meeting of the shareholders in this Company was held on the 20th inst. at the City Terminus Hotel, under the presidency of Sir James Carmichael, Bart., the chairman of the Company.

The SECRETARY (Mr. Edward Tombs) having read the notice convening the meeting, the report of the directors was taken as read. The revenue account stated that the receipts for messages during the half year ended December 31 last had been £2,508, and that the expenditure had been £1,607, leaving net receipts £901, and the sum due from Her Majesty's Goverment to make up the amount guaranteed was £2,698.

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts I need detain you with only few remarks as to the report. It is so far satisfactory that you see our revenue has increased over the preceding twelve months by about £1,000, which has enabled us so far to reduce the amount which we are entitled to call on the Treasury to pay us under the guarantee. The expenses of cable repairs have been small, and they are now in very good working order. It will be in the recollection of some of the shareholders present at the last meeting that it was left in the hands of the board to enter into certain negotiations with the Eastern Telegraph Company to ascertain if possible whether some amalgamation or sale of the property of this Company to the Eastern Company, or if some amalgamation between the two companies could be carried out, and accordingly we made a proposal to the Eastern Company with that object. I think I ought to remind you that no formal resolution was adopted. The impression of all the shareholders present, which I gathered from the expressions then used, was that they thought about £3 would be about the price for your ordinary stock. I left the room under that impression, and upon that we acted in our proposal to the Eastern Company. We suggested to them that they should take over the whole property of this Company, including our cable and concession, but not, of course, our reserve fund, and give us in return for every £10 ordinary share in this Company £3 of debenture stock, bearing interest at 5 per cent., and that they should take over at par our 8 per cent. preference stock, and pay it off in debenture stock at 4 per cent. That was the proposal we made, and in my opinion it was a very fair and liberal offer. Of course, it was made subject to your approval. I am sorry to say that it was met by a distinct refusal, and we have had no counter proposal from the Eastern Company. But I understand that they considered that that was such a very large amount to pay that they are not at all prepared to entertain it. I do not know what they would entertain, but without your authority I should not like to make a further proposal. The next question we discussed was, as our guarantee was coming to an end—it will expire at the end of the present year—whether it was not time to approach the Treasury for an application for the continuation of the subsidy now granted. Pending the negotiations with the Eastern Company, I thought that that would be impolitic, because, supposing we had met with a refusal from the Treasury, it would have reduced the value of our property. I think, supposing our negotiations with the Eastern Company should entirely fall through, that I should then strongly advocate memorialising the War Office and the Admiralty, and of pointing out to them the importance of having a second communication with Malta, which is every day becoming more and more important to England, particularly with the troubles in Egypt, and whether it would not be unwise to abandon the project of a second cable. I think that any objection on the part of the Treasury to giving a guarantee could be got over if the War Office and the Admiralty were in favour of having this second communication. The present guarantee was given when Corfu was under the English flag, and since we parted with Corfu the English Government have no interest in maintaining communication with that place, but they have as regards Malta. The guarantee was to be £7,200 a year—that was the amount we could claim—but during the twenty-four years this Company has been in existence the average drawings from the treasury have amounted to less than half that, namely, £3,200. Therefore, if the Government would reduce our guarantee—we don't want £7,200—if they reduce it, putting Corfu out of the question, and gave us a certain amount of guarantee for the line between Malta and Sicily, we should be in our present position. I think we have a very strong case in going to the Government, because if things had remained in their original state when this Company first started we should never have called on the Government for one penny of that guarantee, but the Government, for purposes of their own—partly for political, partly for Parliamentary purposes—allowed another company to bring a line from Marseilles to Bona, and from Bona to Malta, which entirely took away our South Europe traffic. That was simply because they thought they should not keep other telegraph lines from Malta. We pointed out to Mr. Lowe, who at that time was secretary to the Treasury, what would occur, that if this new line was allowed to land at Malta they must pay a guarantee, as our traffic would be abstracted. It was admitted by the Treasury that we were in the right in our argument, but they said they must take their chance, and the Treasury must make up the dividend. Therefore at that time the Treasury opposed our property and brought on us this extension. That is our case in going to the Government, and it is not through any *laches* that we have had to ask for even half the guarantee. Instead of asking them for £7,200 a year, we have let them off with less than half that. I think it is well worthy of a country like this to have communication with Malta independent of the line by France and the line coming round Lisbon, and I do hope that they may have the good sense and patriotic feeling to give something towards paying for the maintenance of that line. We are entirely in your hands

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and having told you what we have done and what we propose to do, we should like to know if you would wish us to make any further offer to the Eastern Company, and if so, what sacrifice you would make.

The Hon. ASHLEY PONSONBY having seconded the motion,

Mr. J. T. EDMUNDS said that, speaking for himself, he should say that it was decidedly unadvisable at the present juncture to continue negotiations with the Eastern Company. The proper course was for the directors to at once put themselves in communication with the Government to obtain a continuance of the guarantee on the present or some other terms.

Mr. T. ADAMS, in view of the expiration of the guarantee at the close of this year, also thought it was time that the directors approached the Government. The Government ought to have an independent communication of their own, and he thought if the directors put pressure on them they might obtain something. They could not compel the Eastern Company to do anything. He thought that the matter had better be left in the hands of the directors.

The CHAIRMAN: The only question is, do you think we have gone to the extreme in asking £3 from the Eastern Company, or do you think we should have asked £2 10s., £2, or £1 10s.? Would you be satisfied with less than £3? We should not like to be told afterwards that we ought to have asked for less.

Mr. EDMUNDS thought they had asked little enough.

A SHAREHOLDER observed that £3 would be the least.

Mr. ATTRELL stated that outside shareholders could know very little but what the directors told them. The directors knew how far communications had gone on between them. The shares could not be purchased that day under £3, and, therefore, he thought they had gone quite low enough. As a large shareholder in the Eastern Company, he thought the proposal they had made was very liberal. The property was far more valuable to that company than it would be to this Company, because if the Eastern Company took them over they would get rid of a board of directors and the officers, whose expenses were, he said, almost equal to one-third of the dividend.

The CHAIRMAN replied that he had stated the exact nature of the offer made to the Eastern Company, but he repeated it.

Mr. ATTRELL: Then I think you have gone low enough.

Mr. JOHNS inquired what would become of the ordinary stock in the event of their coming to no arrangement with the Eastern Company or getting nothing from the Government. Did the ordinary stock holders in that case go to the wall entirely?

The CHAIRMAN: We should then be left with our cables. One is broken, and there is one between Malta and Sicily, and one between Corfu and Otranto, which are in good working order. Those cables would remain our property. We have also a reserve fund which by then would amount to about £15,000, and we should have our concession from the Italian Government, which has 8 years to run. That is something, and I should not say with that that we are beggars. We might make negotiations with companies that might be started hereafter.

Mr. JOHNS asked if there was a probability of an increase of traffic over their lines?

The CHAIRMAN: Not at present.

Mr. JOHNS: Would all the income, then, be absorbed by the preference shareholders?

The CHAIRMAN: Yes, for the present. Whether you will be able to make better terms with them at the end of the guarantee I cannot say.

Mr. JOHNS presumed that the directors held ordinary as well as preference stock.

The CHAIRMAN: We have no preference stock on the direction. We only hold ordinary stock. We are bound, however, to do our duty by both classes.

Mr. ADAMS inquired whether there was not a roundabout way of getting to Germany, and whether the Company could not get an alliance with that company.

The CHAIRMAN: We could work to England through France, Germany, or Belgium.

Mr. ADAMS thought that something might be gained by setting one interest against another.

Mr. EDMUNDS asked whether, in the event of the whole of the guarantee being taken from them, the cable between Malta and Sicily would earn sufficient to pay the preference dividend?

The CHAIRMAN: We have two cables in working order, one between Malta and Sicily, and one between Corfu and Otranto. They ought to be able to earn the preference dividend. I do not think the ordinary stock would get anything.

Mr. SAMUEL GURNEY, director, pointed out that 8 per cent on the £15,000 of preference shares was £1,200, a year, and it would appear that they made out of messages last year about £1,800. There would, therefore, be something for ordinary stockholders.

The CHAIRMAN: I don't wish you to go away from this meeting under the impression that we shall pay a dividend on the ordinary stock if we cannot get some guarantee.

Mr. EDMUNDS supposed that if the Company amalgamated with the Eastern Company this Company would be wound up voluntarily.

The CHAIRMAN: Quite so.

Mr. EDMUNDS: And the reserve fund would be divided among the ordinary shareholders?

The CHAIRMAN: No; about two years ago there was a discussion on that point, and the legal opinion that was taken was that the reserve fund would belong to all classes equally. In reply to Mr. Attrell, he added that they would do their best for the officers in the event of an amalgamation with the Eastern Company. The negotiations they had had never went so far as to allow that matter to be considered.

The report was unanimously adopted.

The CHAIRMAN then moved, and Mr. ATTRELL seconded, the declaration of the dividends, at the rate of 8 per cent. per annum, less income-tax, on the preference stock, and at the rate of 3 per cent. per annum, free of income-tax, on the ordinary stock, payable on and after the 1st proximo.

The motion having been carried,

The CHAIRMAN said: That closes the business of to-day, and we shall now set to work with Her Majesty's Government, and if we fail it will not be from any neglect on our part.

On the motion of Mr. ATTRELL, a vote of thanks to the chairman and directors was passed, and the meeting then separated.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

Report of the directors, to be submitted to the shareholders at the eighteenth ordinary meeting to be held on Tuesday, the 28th day of February, 1882, at 1 o'clock precisely:—

1. The directors have the pleasure to submit their eighteenth annual report to the shareholders. 2. The accounts for the year show a net profit of £72,299 12s. 8d., after charging the interest on the debentures. To this sum must be added £77,735 0s. 1d. brought forward from last year, making a total of £150,034 12s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 19th, 1881, amounting to £22,410, leaving £127,624 12s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of 15 per cent., or £67,230, being at the rate of £1 16s. per share, and making, with the amount already paid, a total dividend for the year of £2 8s. per share in cash, free of income-tax, leaving £60,394 12s. 9d. to be carried forward to the next account. 3. The operations carried out during the year 1881 have been as follow:—(*a*) The Western and Brazilian Telegraph Company have been supplied with 200 miles of cable, which was carried to Brazil in the month of April by one of this Company's steamships. (*b*) In the month of July, the French Atlantic cable was repaired by the steamship "Scotia," about 200 miles from Brest. (*c*) A cable, 537 miles in length, has been manufactured for the Eastern Extension Telegraph Company, and was laid in the month of November, between Singapore and Batavia, the old cable being afterwards picked up. (*d*) The land lines and the shore ends of a cable which is intended to connect Emden, on the German coast, with Valentia, in Ireland, were completed and laid in October for the German Union Telegraph Company. (*e*) A cable, 550 miles in length, has been manufactured for the Eastern Telegraph Company, to connect Corfu with Trieste, in the Adriatic, and one of the Company's steamships left towards the close of the year to carry out the operation of laying it. It has since been completed. (*f*) The erection of the permanent stations on the Eastern coast of Africa, and their connection with the different sections of the submarine cable between Aden and Natal, have been completed in accordance with the terms of the contract with the Eastern and South African Telegraph Company. 4. The factories at Wharf-road and East Greenwich, together with the Company's ships, are in efficient working order. The steamship "Calabria" has been twice chartered by the Government during the year for the conveyance of troops, &c., to and from South Africa and India. 5. The retiring directors are Sir George Elliott and Mr. Philip Rawson, who, being eligible, offer themselves for re-election. 6. It will be necessary for the meeting to appoint auditors for the ensuing year. Mr. John Gane and Mr. James Glegg (of the firm of Messrs. Quilter, Ball, and Co.), who retire, offer themselves for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES FEB. 22.		BUSINESS DONE WEEK ENDING FEB. 22. Highest.	Lowest
Anglo-American	49,	50	50¼	49¼
Do. Preferred	77½,	78½	79	77½
Do. Deferred	19½,	20½	20¼	19¼
Brazil Submarine	11,	11¼	11¼	11¼
Cuba	8¼,	9	—	—
Do. Preference	15½,	16½	—	—
Direct Spanish	5½,	5¾	—	—
Do. Preference	14¾,	15½	14¾	14¾
Direct United States Cable	10,	10¼	10¼	10
Eastern Telegraph	9¾,	10¼	10¼	9¾
Do. 6 per Cent. Preference	12¾,	12¾	12¾	12¾
Do. 5 per Cent. Debentures, 1899	102,	107	104¼	104¼
Eastern Extension	10¾,	11¼	11¼	11
German Union	9¾,	10	9¾	9¾
Globe Telegraph and Trust Company.	6,	6¼	6¼	6
Do. Preference	12½,	12¾	12¾	12½
Great Northern	11¾,	12¼	12	11¾
Indo-European	28,	29	28¾	28¾
Mediterranean Extension	2¾,	3	—	—
Do. Preference	9¼,	9¾	—	—
Reuter's	12¾,	13	12¾	12¾
Submarine	270,	280	—	—
West India and Panama	1¼,	1¾	1¾	1¾
Do. 1st Preference	7½,	8	7¾	7¾
Western Brazilian	8¼,	8¾	8¾	8¼
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1¾	1 5-16	1 5-16
Oriental	⅞,	1	⅞	⅞
United Telephone	11¾,	12¼	12¼	11¾

ELECTRIC LIGHT.

Electric Light and Power	¾,	1⅛	1 3-16	1 1-16
Anglo-American Brush	8,	8½	9¼	8¼

TRAFFIC RECEIPTS FOR JANUARY, 1882.

COMPANIES.	Jan., 1882.	Jan., 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,800	2,527	273	—
Direct Spanish Telegraph Company	2,055	1,506	549	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,129	29,434	3,695	—
Eastern Telegraph Company	53,648	47,445	6,203	—
Great Northern Telegraph Company	16,960	17,353	—	393

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SLIP

CABLE INTERRUPTED.—The cable between Fao and Bushire is interrupted.

TASMANIA.—The telegraph line from Sorrel to Copping has been completed.—*Colonies and India.*

ELECTRIC LIGHT FOR BESANCON (FRANCE).—The electric light is being introduced into this town.

CABLE REPAIRED.—The cable between Antigua and Guadeloupe is repaired, and communication with Guadeloupe is, therefore, restored.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended February 24 amounted to £3,615.

ELECTRIC LIGHTING BILLS IN PARLIAMENT.—Edison's Electric Lighting Bill was read a second time in the House of Commons on Monday.

BOSNIA AND HERZEGOVINA.—Telegrams in code or cypher are now prohibited to these provinces, as also to (Austrian) Dalmatia and Montenegro.

CABLE REPAIRED.—The Great Northern Telegraph Company notify the repair of their Nagasaki-Shanghai cable, which was broken last week.

ELECTRIC LIGHT IN WEST HARTLEPOOL.—Electric lighting was used for the first time at the West Hartlepool Rolling Mills on the night of Friday week.

ELECTRIC LIGHT IN CANADA.—News from Ottawa says that the new portion of the Welland Canal is to be lighted by electric lights for a distance of 9 miles.

NEW AMERICAN TELEGRAPH COMPANY.—The formation of the Union Electric Telegraph Company, with a capital of 50,000 dollars, is announced from San Francisco.

SOCIETY OF ENGINEERS.—At the meeting of this society on the 6th inst., at 6, Westminster Chambers, a paper will be read, entitled "Notes on Electric Light Engineering."

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of February amounted to £44,046, and to £46,463 in the corresponding period of 1881.

ELECTRIC LIGHT AT LEITH (NEAR EDINBURGH).—The shipbuilding yard of Messrs. Hawthorn and Co., of Leith, was lighted up with the Brush system of electric light early in this week.

THE DISTRIBUTION OF POWER BY ELECTRICITY.—In our note on this subject in last week's issue, for 3·80 kilos. as the useful work obtained by M. Deprez in his experiment, read 38·0 kilos.

ELECTRIC LIGHTING AT NEWCASTLE-ON-TYNE.—The Town Council have decided not to proceed with the provision contained in their Town Improvement Bill for lighting the streets by electricity.

AN ELECTRIC RAILWAY AT MENLO PARK.—It is reported from America that Mr. Edison is actively engaged in the construction of an electric railway at Menlo Park. It is to between three and four miles long.

ELECTRIC LIGHT AT KIMBERLEY (SOUTH AFRICA).—A Reuter's telegram from Cape Town, dated Feb. 7, says:—"Kimberley is adopting the electric light, and it is expected to be ready in about a week's time."

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company for the month of February amounted to £27,473, and to £28,021 for the corresponding period of 1881.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending Feb. 24, 1882, were £2,519, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

ROYAL POLYTECHNIC INSTITUTION.—During the week the various scientific apparatus which have for so long been in use at this institution have been sold, including electric organ, large induction coil, &c. The institution has now finally ceased to exist.

PERSONAL.—We are informed by Messrs. Harborow and Co., electric light engineers, of 4, Circus-street, Marylebone, W., that their business has been purchased by Messrs. Griffith and Co., of the Railway Foundry, Reading, by whom it will be carried on in future.

COMMUNICATION BETWEEN AMERICA AND CHINA.—The New York correspondent of the *Standard*, telegraphing under date Feb. 24, says:—"The Chinese Government has granted a concession to Americans for a land and ocean cable from the United States, *viâ* Japan."

THE TELEPHONE IN CORNWALL.—The United Company have just completed three telephone lines for Mr. Cooper Furniss, of Truro, Cornwall. These are the first lines that have been erected in the neighbourhood, and their working proves thoroughly satisfactory.

THE MIDDLESBRO' CORPORATION AND ELECTRIC LIGHTING.—This Corporation have passed a resolution in favour of memorialising the House of Commons to pass a general Act dealing with the entire question of public electric lighting in opposition to private legislation.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the half month ended Feb. 15 are £2,908, as compared with £2,402 in the corresponding period of 1881. The November receipts, estimated at £4,368, realised £4,384.

ELECTRIC LIGHT FOR WYCOMBE (BUCKS).—The Town Council of Wycombe being dissatisfied with the light afforded by the gas lamps in their streets, have resolved to invite tenders from electric light companies, with the view of introducing the electric light into their streets.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRIANS.—At the meeting of this society on Thursday next, the 9th instant, a Paper will be read "On Measurement in the Medical Application of Electricity," by W. H. Stone, M.A., F.R.C.P., member, and W. J. Kilner, B.A., M.B.

AN ELECTRICAL EXHIBITION AT VIENNA.—It is stated that an International Electrical Exhibition is to be held in Vienna in September next. A committee of organisation has been formed with Count Wilezek and Baron Erlarger at its head. The site of the exhibition will be the same as that in 1873.

CRYSTAL PALACE ELECTRICAL EXHIBITION.—This exhibition was visited last Saturday by the Duke and Duchess of Edinburgh, upwards of 12,000 visitors being present on the occasion. On Tuesday some 300 members of the Gas Institute inspected the exhibits, and on Wednesday the Board of the Midland Railway Company did the same.

THE SOUTH AMERICAN CABLE.—The India Rubber, Gutta Percha, and Telegraph Works Company notify the receipt of

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information that the sections of the Central and South American Telegraph Company's cable from Callao to Payta, in Peru, and from Payta to Santa Elena, in Ecuador, have been successfully laid by their steamship, the "Dacia."

THE SHETLAND CABLE.—On Friday, the 24th Feb., telegraphic communication between Orkney and Shetland was restored, the steamer "Morna" having successfully spliced the broken cable in the Stronsay Firth. The latest news reported this vessel as having gone to Rockwickhay to repair the shore ends of the Pentland Firth cable. She has met with very rough weather since she has been in the north.

ELECTRIC LIGHT AT TRENTHAM HALL.—A few weeks ago we noticed that the Duke of Sutherland had terminated his contract with the Stoke-on-Trent Gas Company for lighting Trentham Hall, one of his country seats, and that incandescent electric lamps were to be introduced in the place of gas. The work of fixing the latter has just been completed by the British Electric Light Company, to whom it was entrusted.

THE TELEPHONE AT WOLVERHAMPTON.—Telephonic communication between the Wolverhampton waterworks at Tettenhall and the pumping station at Cosford, a distance of eight miles, has been completed. The waterworks at Tettenhall are also to be similarly connected with the water engineer's office in Wolverhampton Town Hall. Town Councils generally are beginning to find that the telephone is a great labour saver.

AUTOMATIC FIRE EXTINGUISHER.—Mr. Hiram Maxim has invented an automatic fire extinguisher, in which electricity plays an important part. The system consists of an automatic apparatus, which closes the circuit when the temperature is elevated by fire, a series of pipes containing water at a high pressure, and a series of cocks which are opened by the electric current, and through which water is discharged on the flames.

ELECTRIC LIGHT FOR CINCINNATI (OHIO, U.S.A.).—The Cincinnati Board of Public Works has directed its Committee on Light to obtain information relative to the feasibility of lighting the streets and public buildings of the city with the electric light. The Brush Electric Light Company have offered to light portions of the city with electric lamps, for three years, at a cost of 95 cents per lamp per night, and for two years at 98 cents.

ACCIDENT AT THE CRYSTAL PALACE.—On Tuesday evening last one of the globes of an electric light standard suddenly gave way, and the filament immediately began to blaze. This ignited the gutta percha covering of the connecting wires, and the fire spreading downwards soon shattered the ornamental standard which enclosed them. Here the damage ended, nothing worse happening than the breakage of a few pounds' worth of glass and china.

UNITED TELEPHONE COMPANY v. THEILER.—Mr. Theodore Aston, Q.C., appeared on Thursday, the 2nd inst., before Mr. Justice Fry, in the Chancery Division of the High Court of Justice, on behalf of the United Telephone Company, to restrain Messrs. Theiler and Co. from infringing their patent. Mr. Aston stated that the parties had come to an arrangement under which the defendants submitted to pay the costs incurred, and to a perpetual injunction.

POST OFFICE TELEGRAPHISTS AT LIVERPOOL.—A crowded meeting of telegraphists, held in Liverpool on Saturday evening last, passed resolutions expressive of their indignation at the course of action pursued by their superintendent in seeking to procure the withdrawal of signatures from the petition recently sent to the secretary of the Post Office. The meeting also pledged itself to continue their agitation until all the grievances complained of by telegraph clerks had received full redress.

THE TELEPHONE IN COPPER MINES.—A telephone line has been laid in the Dolcoath copper mine, near Camborne, Cornwall, between the surface and the workings, which are 350 fathoms deep. This is the deepest metal mine in this country, and the working of the instruments is said to be very satisfactory. Doubtless many mines will follow the example of the Dolcoath, as the use of the telephone should prove of great service in facilitating verbal communication between any part of a mine and the surface.

GAS AND ELECTRIC LIGHTING AT NEWCASTLE-ON-TYNE.—It was announced last week that an exhibition of various forms of gas burners and incandescent electric lamps would take place this week in the art gallery, Newcastle, in order to afford a comparison of the relative merits of the two systems. The following were to be exhibited:—A Siemens 1,000 candle regenerative, Bray's, Sugg's, the London and Albo-Carbon Light Company's improved gas burners, and the Swan, Edison, Maxim and Lane-Fox incandescent lamps.

NEW TELEGRAPH LINE AT ABERDOUR (SCOTLAND).—The *Scotsman* of the 27th inst. says:—"After many difficulties, it is expected the new telegraph line from Burntisland to Edinburgh, *viâ* Aberdour, will be in working order to-morrow. In its construction a large staff has been engaged for a month, the first post having been fixed on 4th February. There have been erected 116 poles in all. A large quantity of gunpowder was used in blasting rock for their erection. Though the cable is a seven-wire one, only six land wires are attached to it."

PROFESSOR CHRYSTAL ON ELECTRICITY.—Last week the second of two lectures on electricity, to the members of the Philosophical Institution, was given by Professor Chrystal, of the Edinburgh University. The lecturer described the generation, storage, and transmission of the electric current by dynamo machines, accumulators, &c. Illustrations of sections of various dynamos were given by means of a magic lantern. The lecturer predicted a high place for electricity as a motive power in the immediate future.

THE TELEPHONE IN BELGIUM.—*L'Industrie Belge* learns that, on the resumption of business by the Belgium Parliament, a Bill will be introduced, the object of which is to grant a concession to the Compagnie Belge du Téléphone Bell to establish telephonic communication in towns, but not between town and town. For this concession the Government is to receive 5 per cent. on the net profits. A condition is attached to the effect that at the expiration of five years from the date of the concession all the telephone lines must be underground.

ELECTRIC LIGHT FOR THEATRES.—The *New York Post* states that Mr. H. E. Abbey has made a contract with the American Electric Light Company, of Boston, to put incandescent lamps in the Park Theatre in Boston, and in the Park Theatre, New York. The same authority is answerable for the statement that the lamps of the American Company differ from those used by Edison and Maxim, in that the glass bulb is in two parts, and can be separated without destroying the lamp, so that when the carbon filament gives out it can be renewed at a trifling expense.

ELECTRIC LIGHT AT KINGHORN (SCOTLAND).—Last week the shipbuilding yard of Messrs. John Key and Sons was lighted for the first time with the electric light. This system of lighting has been introduced owing to the press of work now on hand and the want of a good light to enable work to

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be carried on by night as well as day. The dynamo machine with lamps, of which there are six, are those of the Brush Light Company, and the power is obtained from the ordinary engine. The work has been carried out under the direction of Mr. Partridge, one of the electricians of the Brush Company.

Female Telegraph Clerks.—In the House of Commons, on Monday last, Mr. Fawcett said, in answer to Mr. Corbett:—"I am glad to be able to say that the female clerks and telegraphists employed by the Post Office have given general satisfaction. So much is this the case that the employment of women has been gradually and steadily extended. Any claims that they have to promotion will be carefully considered, and I can readily give an assurance that I shall lose no opportunity of still further extending the employment of women whenever it can be done with advantage to the public service."

The Faure Electric Accumulator Company.—The formation of this company is announced, with a capital of £1,000,000, in shares of £10 and £1. The company is formed to acquire all the patents and processes now owned by the "Société la Force et la Lumière" for the United Kingdom, including that of Faure's Accumulator. The chairman of the board of directors is Sir Arthur Otway, M.P. M. Camile Alphonse Faure is one of the consulting electrical engineers. The vendors are to receive £25,000 in cash, and £100,000 in fully-paid deferred shares, which are to bear no interest until 10 per cent. has been paid on the ordinary shares.

A New Battery.—M. C. Senlecq, of Ardres, France, the inventor of the telectroscope, and well known to our readers by his labours in the cause of electrical science, has recently invented a battery which will give a strong current, whilst differing essentially from ordinary forms. No acid is used, and no waste of metal takes place, the latter being, so to speak, renewed by reversals of current, as in secondary batteries. M. Senlecq deposited a sealed packet with the Academy of Sciences, in Paris, at its meeting on the 30th January last, containing a description of his new battery. A description of M. Senlecq's telectroscope, with illustrations, will be found in *The Electrician* for February 5, 1881, p. 141.

Victorian Telegraphs.—In the Victorian Year Book for 1880-81, compiled by Mr. H. H. Hayter, Government statist, is given a table, showing the course of a telegram along the 13,695 miles of wire over which it travels between Melbourne and London. From this table it appears that it travels about one-fifth of the whole distance, 2,704 miles, over Australian lines alone. With reference to the time taken to traverse the above distance, we extract the following paragraph from the Year Book:—"It may be interesting to know that, on the 1st October, 1880, a special message from the Governor of this colony to Queen Victoria, announcing the opening of the Melbourne Internationaal Exhibition, and consisting of 78 words, was sent from Melbourne to Balmoral, in Scotland, in 23 minutes, including all stoppages.

Telegraphs of New Zealand.—In 1871 there were 2,015 miles of telegraph line, and 3,287 miles of wire, open in this colony. The number of private telegrams sent during the year was 305,979, from which a cash revenue of £25,938 was obtained. The number of Government telegrams sent was 63,106, the cash value of which was £11,265 9s. 6d., the total revenue being £37,203 10s. In 1875, the figures were:—Miles of line, 3,156; miles of wire, 7,065; number of private telegrams, 849,919; revenue therefrom, £59,678 11s.; number of Government telegrams, 143,404; cash value, £14,741 11s. 9d.; total cash value and revenue, £74,420 2s. 9d. In 1881, these figures had advanced as follows:—Miles of line, 3,758; miles of wire, 9,587; number of private telegrams, 1,058,342; cash revenue, £73,002 2s.; number of Government telegrams, 246,370; cash value, £27,021 3s. 8d.; total cash value and revenue, £100,023 5s. 8d.

Paris Electrical Exhibition.—According to a report on this Exhibition, which has recently been issued by M. Cochery, Minister of Posts and Telegraphs, the total number of exhibitors was 1,764. Arranged according to their nationalties this total was made up by—France 937, Belgium 281, Germany 148, England 122, Italy 81, Russia 38, Austria 36, Spain 23, Sweden 23, Switzerland 21, Norway 19, Netherlands 18, Hungary 10, Denmark 5, Japan 2. The admissions by payment numbered 673,473, and the free admissions to schools, workshops, &c., were very numerous, the last two free days having 80,000 visitors. The receipts, including 200,000f. from the State and 25,000f. from the Municipality, amounted to 1,048,417f. The expenses already paid reach 689,490f., and after clearing off a few outstanding bills, the net surplus is expected to be 325f. This sum is to be devoted to the foundation of a central laboratory for electrical experiments.

Telegraph Extensions in Scotland.—A reply was received last week by Sir Donald Currie, M.P., from the Postmaster-General, in answer to a petition presented by that gentleman on the 20th July last, praying that telegraphic communication might be extended to out-of-the-way places in Scotland under a somewhat less onerous burden than the seven years' guarantee required by the General Post Office. After mentioning that the petition had been forwarded to the Treasury, the letter, which is dated Feb. 21, says:—"Their Lordships have just informed me that as there is still a deficit on the telegraph account, and the guarantees which the Department has always asked for telegraph extensions estimated to be unproductive are no more than sufficient to secure the Exchequer from further loss by such extensions, they are not disposed to relax the present guarantee conditions. I regret, therefore, that I am unable to comply with the appeal from the Scotch members of Parliament for the telegraph lines to be extended to out-of-the-way places in Scotland under a modified form of guarantee."

Atmospheric Electricity.—At a recent meeting of the California Academy of Sciences, Mr. C. D. Gibbes, C.E., remarked that when surveying during the north winds, which are prevalent at certain times of the year, in the San Joaquin valley, the electrical disturbance was so great as to cause the needle of his compass to fly up against the glass and become useless during the first part of the day when in the field; but that if he took the same compass into a warm moist room it again acted normally. Engineers in Santa Clara and Calaveras counties report the same action and dip of the magnetic needle during the prevalence of the dry north winds. Dr. Harkness said these winds affected the human skin. Dry atmosphere was a perfect non-conductor, but all moist plants and animals, as well as men, then became so many miniature lightning rods. The nerves were at such times continually irritated by a constant succession of tiny blows, like telegraphic ticks, against the nerve centres. They contracted and produced a congestion of the organs; the blood became turbid, while kidneys, liver, and lungs all suffered.

Postal and Telegraph Department, Queensland.—We have received a neatly got up Christmas card, issued by the officials of the Post and Telegraph Department of this

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colony. On one side are illustrations of the way in which the mails are conveyed and delivered in town and country, and on the reverse some interesting statistics of the progress made by the two services since their introduction into the colony. The superintendent of telegraphs is Mr. A. F. Matveieff, to whom we are indebted for the card. The colony was established in 1859, and the telegraph service in 1861. The revenue derived from the service in that year amounted to £938, and in 1880 to £35,878. The expenditure in 1861 was £1,652, and in 1880, £63,565. The number of offices at the two periods was 7 and 159 respectively. The telegrams transmitted and received in 1861, amounted to 6,189, and in 1880 to 574,445, the cash value of which was £938 and £35,878, and the value of Government messages £122 and £10,421. In 1861 there were 169 miles of line, and 169 miles of wire, in 1880 these figures had increased to 5,768 and 8,149 respectively. The telephonic system was established in October, 1880.

Post Office Telegraph Clerks.—In the House of Commons on Tuesday Mr. Macliver asked the Postmaster-General whether, in applying his recent scheme for improving the position of the telegraph clerks, he was aware that an undue proportion (75 per cent.) of the superior appointments had been given to postal clerks of limited service, while telegraph clerks of 15 and 20 years' service had been passed over; whether he would endeavour to allay the dissatisfaction which such alleged partiality had occasioned; and whether the delay in applying the scheme to Bristol and Plymouth could not be shortened.—Mr. Fawcett replied that when the scheme which was sanctioned last year for improving the position of the postal clerks and telegraphists with regard to pay and promotion came into operation it was necessary to introduce a new classification into every post-office in the United Kingdom where an established force was employed. This was necessarily a work of much difficulty and complexity. Many hundreds, even thousands of promotions had to be considered; and he could with confidence assert that there had been no intention whatever of doing the slightest injustice to the telegraphists, but that in every instance the claims arising from seniority and fitness had been most carefully weighed. With regard to the latter part of the question Mr. Fawcett said that the scheme for the new classification of the Plymouth post-office had been already sanctioned, and the scheme for Bristol would be in the course of a few days.

On Wheatstone's Bridge.—The following article, by K. F. Slotte, is reproduced in the *Phil. Mag.* for March from "Wiedemann's Annalen," for 1882, No. 1:—"The length of the platinum wire belonging to this apparatus, which cannot be exactly determined by measurement, can, it is well known, be ascertained indirectly by comparing and exchanging resistances. The following procedure is a modification of this method which may not be without advantages. Let s be the length of the wire, a and b that of its two divisions when two resistances, w_1 and w_2, are inserted and the galvanometer shows no current. Then is

$$\frac{w_1}{w_2} = \frac{a}{b} = \frac{s + a - b}{s - (a - b)} = \frac{s + d_1}{s - d_1}, \quad . \quad . \quad . \quad . \quad (1)$$

in which $a - b$ is put $= d_1$. If now the resistances w_1 and w_2 be exchanged, and the movable contact shifted till again no current passes through the galvanometer, this displacement, taken as positive or negative according to whether a is more or less than b, is equal to d_1, which quantity can be directly determined by reading it off upon the scale of the apparatus. If in the same manner w_2 be compared with a third resistance w_3, and, again, w_3 with w_1, and if the displacements corresponding to d_1 be denoted respectively d_2 and d_3, then we have

$$\frac{w^2}{w^3} = \frac{s + d_2}{s - d_2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\frac{w_3}{w_1} = \frac{s + d_3}{s - d_3}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (1), (2), and (3) we get

$$1 = \frac{(s + d_1)(s + d_2)(s + d_3)}{(s - d_1)(s - d_2)(s - d_3)},$$

and finally, by solving the last equation,

$$s = \sqrt{-\frac{d_1 d_2 d_3}{d_1 + d_2 + d_3}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Three determinations effected by this method, in which w_2 was chosen approximately equal to $\sqrt{w_1 w_3}$, gave for s the values 1118·11, 1118·75, 1118·6 millim.

Gas and Electric Lighting in New York.—Our contemporary, the *Sanitary Engineer* of New York, makes the following remarks in its issue of the 9th February, which may be commended to the careful attention of our contemporaries who represent the gas side of the question. Our contemporary says:—"The manager of the gas works in a small English town made a visit to this country recently, and since his return has been entertaining the readers of a local newspaper with an account of his experiences here. Among other things, it appears that he witnessed the experiment which is being made in this city of lighting certain of our streets with electricity, and the following extracts from his observation will be of interest, as showing how an English gas manager *may* look at our electric lighting, and how easy a matter it is to misstate the true merits of a case when our interests are directly or indirectly involved." Here follow the extracts, in the course of which the words "*fiasco*," "costly," "eccentric," "fantastic," "dangerous," are freely applied to electric light. Our contemporary in criticising these remarks continues:—"These statements would not naturally attract very much attention, except as they were given further publicity; but as they have been copied by papers having a wide circulation they seem to call for a word of comment. . . . As to the assertion that the electric lighting is a "*fiasco*," the value of such a judgment depends entirely upon the question whether the person expressing it is thoroughly unbiassed. We are safe in saying that the New York public do not consider the experiment in this very unfavourable light, although the imperfections of the system are thoroughly appreciated. Moreover, no fair observer can claim that the electric illumination is inferior in the amount of light to that obtained by the use of gas. We have heard of cases where persons found it 'extremely difficult to perambulate' the streets without much regard to the nature and extent of the illumination. We have not heard of any accidents resulting from a deficiency of light, nor have we seen more ladders about the electric than about the gas lamps. We do not appear as a champion either of electric lighting or of gas lighting, but are friendly to both. We believe in giving the electric light a fair chance. The constant spirit of fault-finding and unfair criticism which has become so common on the part of many having supposed rival interests at stake, while it may be in perfect accordance with human nature, is not to be very highly commended. The early days of gas lighting were not all sunshine; and any scheme which aims at the utilisation of natural forces may ask, and certainly should have, every opportunity for its development."

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CRYSTAL PALACE EXHIBITION.

Last Saturday the Duke and Duchess of Edinburgh visited the Exhibition. Great efforts had been made to have the exhibits completed, and, with slight exceptions, the collection looked as if a few more touches only were required before the whole was in place. An empty stand here and there, a few lamp-posts with no lamps—such were the signs of incompleteness. On the whole, however, the sight was exceptionally grand. We who saw the French Exhibition during the opening week, and later on when the lights were all in action, are compelled to acknowledge that the individual exhibits at the Crystal Palace are far before those at Paris. We had thought that the first Exhibition would not readily be equalled, but it has been surpassed. There were no means of exhibiting the electric light at Paris so that the individualities of each light could well be estimated, but here the case is different. The capabilities of the incandescent light must now force themselves upon the visitors—except such visitors as are endowed with the feelings and ideas expressed by our eloquent gas contemporaries. But who so blind as those who will not see? It is not in the large array of lights with gorgeous and fantastic chandeliers that we claim the greatest merit for the electric light, but in those single lamps, if arc lamps, arranged singly, if incandescent lamps, arranged perhaps less in number than would be gas jets placed in the various courts. Here the light approximates to what it should be in our own rooms, while the clusters appeal to us from a different standpoint.

Last week we described the machines exhibited by the

Electric Light and Power Generator Company.

We shall this week describe the lamps exhibited by them. Since our previous article was written great additions have

Fig. 1.—Maxim Incandescent Lamp.

been made to these exhibits. The most important addition is an Electrolier, which we hope to illustrate in our next issue, designed and manufactured specially for this exhibit by Messrs. J. Defries and Sons, of Hounsditch. It is of cut crystal, designed for 100 lights, and stands over twenty feet in height. The style is the floriated Gothic. But more of this hereafter. The same makers have designed and made a ball room electrolier, representing a basket, of pure cut crystal, in which a Weston arc lamp is suspended. This is shown in the Roman Court, and is one of the single lamps to which we have previously referred. Gas chandeliers of great beauty are to be met with over and over again, but we certainly think that in the Crystal Palace the electric light is

In garb of greater brilliancy attired,

and that the various clusters of Lane-Fox, Maxim, Edison, and Swan lamps will enable men to realise beauties in interior decoration which have hitherto not been attempted.

So far as we could ascertain on Saturday last the company exhibited lights on three circuits. In one of these circuits were 96 Maxim lamps on the electrolier, and two lamps with the machines, in all 98 lamps. The current for these lamps was obtained from Maxim machines, one exciter, and one distributor. We understand that the regulator described last week has been constantly and satisfactorily used for some days past. Fig. 1 shows the type of Maxim lamp. The carbon is flat, and shaped somewhat like an M. Its resistance is, we are informed, about 30 ohms. In circuit No. 2 were 40 lamps on electroliers; 9 single lamps arranged along the cloisters; 12 lamps on two street standards, each standard carrying six lamps; and one lamp with the machines, or a total of 62 lamps. On the third circuit, with current from a Weston machine, were the various Weston arc lamps exhibited. The Weston arc lamp is simple in construction and reliable in its action. It has been considerably modified since Professor Merton's trials were carried out, but the figures obtained in 1879 will be interesting historically, and, therefore, we give Tables 17 and 18 from the report, the one giving the results of the trials with Weston machines and lamps, the other with the Weston machine and Maxim arc lamp.

Table 17.—Trial of Weston Machine with Weston Lamp Nov. 21, 1879.

Time.	Candle-power.	Horse-power.	Candle-power per Horse-power.
9:20 p.m.	5,664	4·5830	1,236
9:22 ,,	5,210		
9:25 ,,	8,496	4·3211	1,966
9:28 ,,	5,664		
9:30 ,,	5,664	4·7509	1,192
9:32 ,,	6,018		
9:35 ,,	5,664		
Average			6,063
,,			4·552
,,			1,332

Table 18.—Trial of Weston Machine with Maxim (arc) Lamp, Nov. 21, 1879.

Time.	Candle-power.	Horse-power.	Candle-power per Horse-power.
8:15 p.m.	7,788	4·3378	1,795
8:18 ,,	8,000		
8:20 ,,	6,645	3·6986	1,797
8:22 ,,	7,363		
8:27 ,,	6,018	5·4960	1,095
8:30 ,,	7,930	5·5330	1,433
8:32 ,,	8,850		
8:35 ,,	7,788	4·7509	1,639
8:37 ,,	8,142		
8:40 ,,	8,496	4·2813	1,984
8:45 ,,	8,638		
Average			7,787
,,			4·683
,,			1,663

Fig. 2 shows the general appearance of the Weston lamp, the mechanism being wholly within the brass case through which the rod carrying the positive carbon passes. An enlarged view of the mechanism is shown in Fig. 3. R R shows the carbon rod, which when no current is passing slides freely through the clutch lever C, the upper carbon under these conditions resting upon the lower. M M is an electro-magnet constructed as shown in section in Fig. 4. Each core of the magnet is wound with three coils—two of thin wire, one of thick wire. The coil of thick wire is in the lamp circuit, those of thin wire in a shunt circuit. The coils are wound differentially—that is, the thin wire is opposite in direction to the thick wire, and therefore currents passing through the one are opposite in direction to those passing through the other. If the currents in these coils are equal the inductive action is neutralised, and the coil does not act as a magnet upon its armature; if, on the contrary, one current is stronger than the other, it impresses its polarity upon the magnet, and so on. A A shows the armature, which is

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capable of motion in a vertical direction only, being supported by the flat parallel fixed steel springs N and O.

In its position of rest the upper end of the armature is just a little below the lower edge of the upper pole of the magnet, so that the action of a current being sent through the magnet coils is to cause the armature A to be attracted vertically, thereby lifting the end of the clutch lever C, to which it is attached, and this lever is so constructed that when it lifts beyond a certain point it seizes and lifts the rod R. A tension spring, S, is attached at its upper end to the top of the armature, and hooked at its lower end to the arm of the bell-crank lever L, fixed in such a position that the tension of the spring S can be regulated by an adjustment screw shown in the figure. The movement of the armature, therefore, is controlled by the varying attractive force of the magnet MM drawing it upwards, and the adjustable tensile force of the spring S pulling it in the opposite direction; and, in order to prevent a sudden and violent variation in

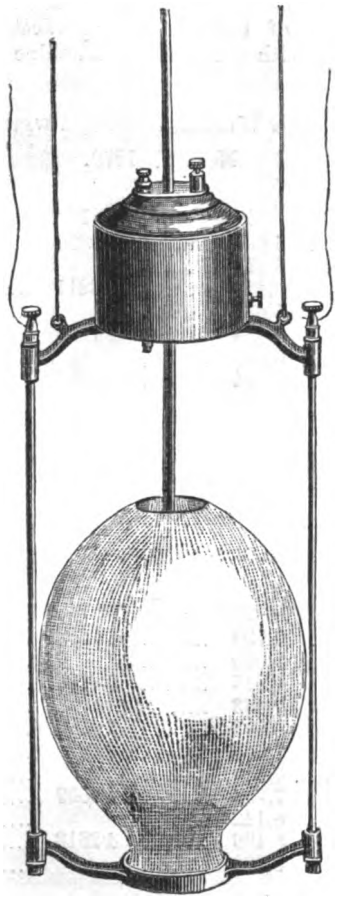

Fig. 2.—Weston Arc Lamp.

the attractive influence of the magnet from setting the lamp "jumping," the lower end of the armature is attached to a small piston rod and piston, which works in a little cylinder or "dash-pot," G, containing glycerine, in which the piston is immersed, and the controlling action of this little contrivance can be adjusted within certain limits by allowing more or less glycerine to pass from one side of the piston to the other. This adjustment is effected by a very simple contrivance. The piston of the glycerine cylinder is made of two discs, the one fixed to the piston rod and the other capable of being rotated through a small angle on its centre, which is coincident with that of the other disc as well as with the axis of the piston rod. Around the edges of both discs are cut three notches at equal angular distances apart of 120deg., and, by the angular position of the movable disc with respect to the fixed disc, the rapidity with which the glycerine can pass from one side of the piston to the other can be regulated with great nicety by the opening or closing of the notches as they coincide with or pass by one another. The discs are shown in elevation in Fig. 3.

The action of the current is as follows. At first entering at the upper right hand terminal the current passes through the thick coil of the magnet, making it active, and thus raising the carbon and forming the arc. But a part of the current goes through the fine wire of the coils—how much depends upon the length of the arc, and therefore the resistance of the main circuit. The current obeys the well-known law, being inversely as the resistances. Now, suppose $x + y$ signifies the total current, x being the normal resistance of

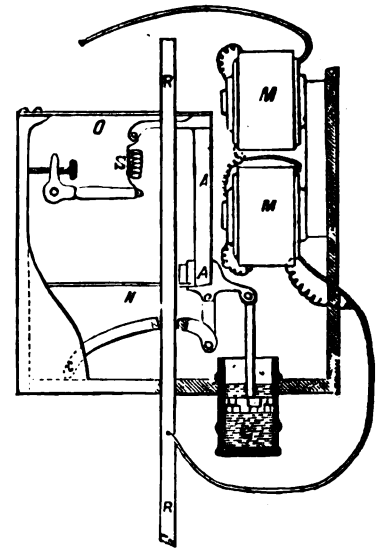

Fig. 3.

the main circuit when the arc is at its best length, and y the resistance of the shunt circuit, the value of y being far greater than the value of x. For simplicity, suppose that $x = 1$ and $y = 99$, the total current being represented by 100, then 99-100ths of the whole current in the normal state goes through the main circuit, and 1-100th through the shunt circuit. If, however, the main circuit increases in resistance by the lengthening of the arc, a less current will go through it, and a greater through the shunt. This greater shunt current partly neutralises the main current in

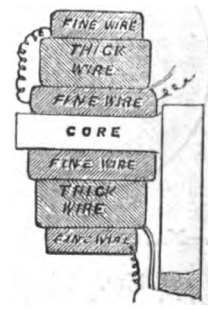

Fig. 4.

the magnet, and hence weakens the magnet, and the carbon falls, thus shortening the arc. It must be allowed that the arrangement is pretty, and so far as our information goes it is effective.

The Electric Light in Toulon.—*La Lumière Electrique* says that the Town Council of Toulon have just granted a subvention of 1,500 francs to the manager of the Grand Théâtre of that town to enable him to establish a system of electric lighting in the theatre. The preliminary trial of the lights is to take place shortly.

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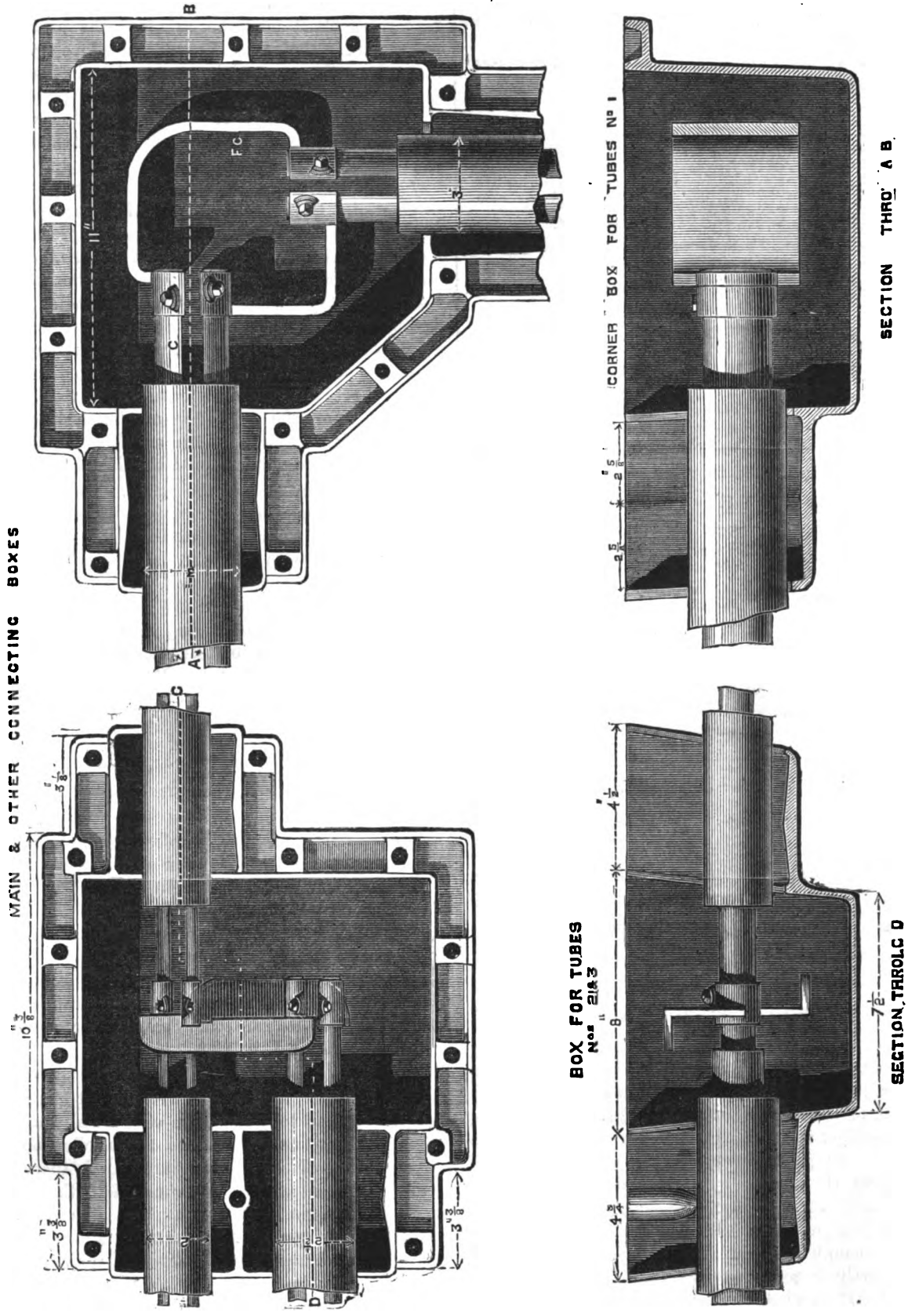
EDISON'S FUSIBLE CONDUCTORS.

An important part of Mr. Edison's arrangement is that which provides against fire. It can easily be understood how from some unforseen cause a current might be sent into conductors which fuses under a certain current. This fusion current is, of course, somewhat greater than that which the conductor is designed to carry, and less than that which



a main stronger than the main was assigned to carry. This strong current would heat the wire, and possibly cause serious mischief. To guard against such mischance, Mr. Edison inserts a metallic fusible connection between his would raise the conductor to a dangerous temperature. Our illustrations, besides showing the fusible conductors, show various street boxes, &c., as used for getting at or making junctions. Specimens are exhibited at the Crystal Palace.

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NOTICE.—OUR SUPPLEMENT.

The supplement containing "Hints to Electric Light Engineers," published with our issue of the 7th January, can now be had at the office in pamphlet form, price one penny. In reply to several of our friends we may say that our next Supplement is in active preparation, and we hope to be able to issue it shortly.

SECONDARY BATTERIES ACTUAL AND POSSIBLE.

A good deal of curiosity has lately been aroused by rumours relating to a new storage battery, or electrical accumulator, as it has been called, which is said to be nearly ready for the market, and is, of course, like all new things, to completely eclipse the old. As these vague rumours begin to take definite shape we notice, however, indications of something more than mere curiosity—something, indeed, which looks more like anxiety, a feeling which we need hardly say is foreign to the true spirit of science, though it is common enough in trade. If the inventor of the new battery has anything good in store for us he should be welcomed most heartily, whatever the commercial consequences may be; and we are sorry, therefore, to see that something very like an attempt to discount his invention beforehand is now being practised. At all events, that is how such letters as that which appears in another column, addressed to us by Mr. Seaver, strikes us, and to some extent, also, that addressed to *The Standard* on Wednesday by Professor Ayrton.

We are the more justified in putting this construction on such communications as these, seeing that the representatives of the Faure method of storing electricity were by no means innocent of resorting to the usual devices for exciting public interest, which, it must be admitted, the promoters of the new system in their turn appear to be adopting. Nor can we admit for one moment the assumption that any serviceable improvement on the Faure battery would "practically exceed the limits of possibility," or would necessarily invade "the processes covered by Mr. Faure's patent." Both these assumptions may be true; but they are purely conjectural, and, except among very sanguine holders of shares, cannot be regarded as prophetical. Professor Ayrton is, of course, quite correct in his statement that it is "surely somewhat premature to compare the relative durability of the two cells," one of which has been "in constant use for many months," whilst the other is "not yet before the public" at all. But such an obvious truism was hardly worth communicating to the newspaper, one would imagine; and when we remember the uncommonly premature character of the predictions put forward concerning the Faure battery at a time when it was "not yet before the public" we are inclined to ask what is the meaning of this newborn caution and this excessive solicitude lest the public should be misled.

For a determination of the relative merits of these two competing systems—for we suppose it may now be taken that there is a competitor in the field—we ourselves are content to wait with patience, but at the same time with fairness and an unbiassed mind. The Faure battery is an excellent one, and the world has good reason to be grateful that a practical means of storing electricity was devised just when the promotion of electric lighting stood greatly in need of a storing system. But so far from its being at once apparent that nothing could beat the system then patented, we venture to say that the first thought concerning it among many practical electricians was that, its superiority over the original Planté battery being so inconsiderable, a more substantial improvement would shortly be forthcoming.

That such improvement is called for there can, we think, be no question. Like the "new electric accumulator," the Faure battery was all that figures could make it—in the laboratory; but in practical application it has not, to say the best for it, answered every expectation. And this in all likelihood will be the case with its rival. Still, there is plenty of room for improvement, and while entertaining the profoundest respect for the Faure system, we cannot sympathise with the notion that it is either so good or so sacred that it may not be amended.

We could wish that the whole facts were before us; but, so far as the existing system is known to the general public, it does not appear to have been economically a success in lighting railway trains, and its non-application to several purposes for which it was anticipated there would be ample scope suggests the conclusion that some economic or practical objection bars the way. As regards the new system, it seems that a company has been formed, and all the capital subscribed privately. Further, if rumour may be trusted, the laboratory experiments have been highly encouraging. We have been promised specimens of these new batteries to test, under our own conditions and in our own laboratory, a work which we have never been able to accomplish with batteries made by the Faure system, except such batteries as we have made ourselves.

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We shall fairly test the new battery when submitted to us, and shall take the first opportunity of giving the details to our readers. Within another week or ten days the battery will, we are informed, be used at the Crystal Palace to supply the current to one of the electroliers, and then the public can judge somewhat between the rival competitors for their favour. We are informed from another source again that laboratory experiments made with plates of two square inches of surface, charged for two hours by means of three bichromate cells, and even then not fully charged, gave an almost steady deflection for twenty-four hours upon a galvanometer having a resistance of about 135 ohms. We give these rumours for what they are worth. They are not conclusive, they may be illusory; but we are sure they are put forward in good faith, and we see no reason to doubt them. The public certainly ought to be cautious in this as in all matters upon which they cannot themselves form an opinion; but, on the other hand, it is clearly the interest of the public to encourage improvements, and we deprecate any action tending to frighten them away from the market before they have been fairly examined.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

X.

The Unit of Current.

The measure of current ultimately rests upon the three fundamental units of length, mass, and time, and its dimensions are easily found to be the same as those of the square root of a mechanical force, that is

$$\frac{\sqrt{\text{mass}} \cdot \sqrt{\text{length}}}{\text{time}}$$

If, then, forces (involved in the definition of unit magnetic pole) be expressed in dynes, the current is expressed in C.G.S. units, and the unit is called the C.G.S. unit of current.

This unit current happens to be a pretty strong one; if sent between two carbon poles it would give a very fair electric light. A Daniell cell, to produce unit current through a short copper wire, must be so large that its resistance is only the tenth of an ohm.

The tenth of a C.G.S. unit is what is known among practical electricians as a *weber*.

The unit current may be expressed in various ways thus: Unit current is that which produces unit magnetic potential at a point from which the circuit in which it is flowing subtends unit solid angle.

The unit current is that of which unit length produces unit strength of field at a point unit distance from it; in other words, of which unit length acts with unit force on unit pole one centimetre distant from every point of it. [For this to be possible the wire must, of course, be bent into the arc of a circle.]

If unit current flow once round a circle of unit radius a pole at the centre of the circle is driven along the axis with a force of 2π dynes.

A unit current flowing in a circle 4π, or $12\frac{1}{2}$, centimetres in diameter, produces unit magnetic field at the centre.

A circuit of one square centimetre in area, and conveying unit current, if placed edgways in a field of unit intensity, would have unit potential energy; *i.e.*, would do unit work by turning itself slowly into its stable position normal to the lines of force; and it would experience unit couple tending to turn it into that position.

Electro-dynamometers.

So far we have supposed that the magnetic force at a convenient measurable distance from a circuit conveying a current is determined by placing a small magnetic needle there; and that from the deflection of this needle against either the earth's magnetism or a torsion thread, the magnetic force, and ultimately the strength of the current, is calculated. But we are not bound to use a needle at all, we can employ instead of it a small movable coil of wire through which the same current, γ, circulates as through the large fixed coil.

Starting with the planes of the two coils at right angles, so that no lines of either thread the other, we can determine the moment of the couple tending to turn the plane of the movable coil through a right angle; into the position, that is, when each includes as many as possible of the other's lines of force—the position in which the current is circulating round both coils in the same direction.

Now supposing it were possible to suspend or pivot the movable coil, like a magnetic needle, with practically neither torsion nor friction, we could treat the arrangement like a galvanometer: the movable coil (if its effective area be called A) would act simply like a needle of moment γA, and the equating of the couples when the movable coil has rotated to its steady deflection θ, would give

$$G\gamma \cdot \gamma A \cos\theta = \gamma A H \sin\theta,$$

$$\text{or } \gamma = \frac{H}{G} \tan\theta,$$

as before.

But it is not possible so to suspend a movable coil, and at the same time to send a current continuously through it. We must suspend it by the two wires which convey the current to and from it, and must take their torsion into account. And to avoid complicating matters by mixing up the earth action with the torsion, we may arrange it so that the movable coil starts from a position when the earth's couple on it is zero, and we may bring it back after deflection to this position by turning a torsion head, the angle of torsion being read off.

In setting the instrument, then, the plane of the fixed coil (or coils) is to be arranged in the meridian, and that of the movable coil perpendicular to it. After establishing the current, the torsion head will require to be turned through a certain measured angle, α, to bring the movable coil back to its original position; and the torsion moment may be called $T\alpha$, where T is a constant depending on the dimensions and material of the torsion fibre. Under these circumstances the earth has no effect, and the equation is simply,

$$G\gamma \cdot \gamma A = T\alpha,$$

or

$$\gamma^2 = \frac{T\alpha}{GA}.$$

The peculiarity of the electro-dynamometer as so used is just this, that it measures the *square* of the current, and, therefore gives precisely the same reading for equal currents of opposite sign.

Hence it can be used, and it is about the only thing that can be used, to measure the strength of rapidly-alternating currents. It gives the mean numerical value of these currents without regard to sign.

Measurement of Strong Currents.

In measuring very strong currents by a galvanometer it is not conducive to accuracy to permit the observed deflection to get too near a right angle—not much nearer, say, than 60°. To keep the deflection down, the ring may be made very large, since its effect varies inversely with its radius; or it may be rotated through an angle ψ about a horizontal meridianal axis, as in an instrument known as Obach's galvanometer, so that the horizontal component of its field, $G\gamma \cos\psi$, is but small. But this is not a pleasing arrangement, if for no other reason than because the vertical compound, $G\gamma \sin\psi$ alters the total vertical field previously acting on the needle and disturbs its balance.

Another and good plan is to shunt most of the current through a small known resistance, and to use a galvanometer of many turns.

But all these methods depend on the horizontal intensity of the earth, and require it to be known. Now, in an electrical workshop, where strong currents are employed, very

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little can be certainly stated regarding the earth's lines of force at any point, so much will they be disturbed by surrounding currents and magnets—unless, indeed, a special observation be taken by swinging a magnet at the required place.

An independent and powerful field of force has, therefore, been made for the needle, by putting it between the poles of a magnet so strong that the earth and all other magnets may be neglected. In this case the graduation of the galvanometer is usually empirical.

Ayrton and Perry's very satisfactory instrument on this principle has the great advantage of being beautifully dead-beat. It shows distinctly the passage of the junction of the belt over the pulley of the dynamo.

CABLE SHIPS.

The following is a translation of a communication from the Director-General of Customs in Spain, in reference to the treatment of cable ships and the transhipment of cable, in the port of Vigo, to which we recently referred:—

"Vigo, February 16, 1882.

"Direcion General de Aduanas.

"The following Royal Order has been communicated to this Direction-General by the Minister of Finance, dated the 10th January.

"Sir: Having in view a petition presented by the representative in Madrid of the Eastern Telegraph Company, requesting that the Customs authorities of Vigo should facilitate the transhipment of cable material when vessels charged with the repair of these means of communication require to effect such operations, His Majesty the King, agreeing with what you have proposed, has been pleased to resolve—1st, that when the steamers indicated are solely and exclusively dedicated to the repairs of submarine cables, they are to be allowed to tranship, although the ships' manifest may not express the amount of material to be transferred; and, 2nd, that when this class of vessel does not carry any cargo other than cable for laying in the sea, they may be admitted with a manifest, simply signed by the captain, stating the cable, provisions, and stores, this document to be presented to the Custom House officer immediately on entering the port.

"The foregoing is communicated to you by Royal Order for your knowledge and guidance.

"The above for your knowledge, Madrid, 4th February, 1882.

(Signed)

"P. V. Pedro de Alcantara de Ezsiza.

"To the Representative of the Eastern Telegraph
"Company, Madrid."

TELEPHONE WIRES.

We have received the following copy of a letter addressed by the Secretary of the National Telephone Company (Limited) to the Town Clerk of the City of Edinburgh:—

(Copy.)

"Sir: On behalf of the Company, I have to thank you for favouring me with the terms of the report of the City Superintendent on the proposed regulation of telephone wires.

"The directors feel sure that you fully recognise the public convenience which is afforded by the Company's system, and the great difficulties which have to be contended against in carrying on the business.

"I can assure you of the Company's willingness to meet the views of the council in every possible way so as to secure the safety of the citizens and the amenity of the town, and I shall deem it a favour if you inform me from time to time of any views on the subject which the magistrates consider it necessary to express.—I am, Sir, your obedient servant,

(Signed) "George E. Watson,
"District Secretary.

"William Skinner, Esq., Town Clerk,
"City Chambers, February 27, 1882."

CORRESPONDENCE.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: A paragraph appeared in *The Times* of the 25th February, which has been reproduced in other newspapers, announcing the advent of a new electric accumulator, stated to be infinitely superior in durability and storage capacity to that of Faure.

During the past six months similar announcements have repeatedly been made, not only here but in America and on the Continent, but up to the present we are not aware that any accumulator other than Faure's has really given any proofs of its existence in a practical shape.

The inventors of the "new" accumulators would confer a great boon on the public if, instead of continually announcing their "future" appearance, they would boldly come forward and, having the courage of their opinions, state publicly, as Mr. Faure has done, by what process they have arrived at such marvellous results, and what metallic substances they employ which enable them to so far surpass the storage powers of Faure's batteries as to practically exceed the limits of possibility, having due regard to useful industrial applications and durability.

Indeed, it would be rendering a rare service to science and to such high authorities on electricity as Sir William Thomson and Professor Ayrton to at once disabuse their minds of the conviction recently expressed by these gentlemen that, in the present state of electric science, it does not seem to them probable that an accumulator superior in its varied qualities can be produced without employing the substances and processes fully covered and protected by Mr. Faure's patent.—

Yours, &c.,
F. J. Ricarde-Seaver.

Conservative Club, St. James's-street.
March 1, 1882,

ZANZIBAR.—SULTAN'S LEVEE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The enclosed incident in the life at a Cable Station will, perhaps, interest your readers:—

"Six o'clock, sir."

In our English homes this is the summons that, with a rat tat tat, would fall upon an unwilling ear so early in the morning. Here, in Zanzibar, we have to put up with the Swahili equivalent, "*Sasita, bwana*," which sounds anything but musical from the lips of a black boy. For this reason, it is not conducive towards waking me nicely, or provoking a good-tempered yawn, a stretch, and then a quiet slip out of bed. On the contrary, the announcement is unwelcome; it grates upon my ears most disagreeably this morning—so much so that my hand hurriedly travels over the side of my bed in search of a boot or slipper; but the curly head has wisely disappeared, and the disappointed member returns to my side.

Six o'clock! The niggers outside make noise enough for midday. I venture to vouch that consumption is not a disease very rife amongst the Swahilis. They are veritable stentors! Lungs of brass, skins of leather, skulls of adamant. To-day their lungs seem to me to be particularly strong, as the twaddle of their many voices ascends into the peace-laden atmosphere of my room, and drives me frantic. A *thin*, plaintive voice issuing from the massive mouth of a nigger would be regarded as a freak of nature, and listened to with the utmost curiosity. Would that one would suddenly make itself heard in their midst, plaintively crying out, "House on fire half a mile away!" Then would I be relieved of this chaotic uproar.

But I must get up. Have I not to attend the Sultan's reception at 9 o'clock? The thought of it brings up my temperature to fever heat. The thermometer registers 82 degrees Fah. now. By and bye what will it register? I dare not think of it.

Oh, my gums! In my vehement excitement I have scrubbed

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them until the blood has come—"Boy, take out my dress suit, clean shirt, &c., &c." This order is delivered in gasps, so overcome am I by the idea of dressing. Oh, ye Arabs, ye Banians, ye Hindees, ye Swahilis, who always look so cool in your airy garments, how I envy you all! I must seek solace in the matutinal tub and endeavour to forget the coming ordeal. Cool, refreshing—I wish I could remain in the water all day. But, bother these links, they are very stubborn this morning, and that wretched dhobee has starched my shirt so terribly that I feel like a foreign soldier in his uniform stays. I *cannot* tie this cravat; everything is against me. On the bed-rail hangs the swallow-tail. I hate the sight of it. Woven, cut, sewn, misshapen piece of West of England cloth —blacker than a nigger—would that you were supplanted by swallow-tails of fine linen in this warm climate.

"Breakfast!" Ha, a respite. What, "*No ice?*" "Holiday Ice Factory, saahb." Shades of King Frost! what am I to do? "Ice bad for libber, saahb." "What do you mean, you jackanapes? What do you know about the liver? If I told you yours was in your elbow you could not contradict me. Pull the punkah and drive these flies down below." Oh, that villanous cook! the coffee is boiling, and I have taken *such* a mouthful. I *must* swallow it, otherwise the servant will smile behind my back. The toast is like slices of brick. The kidneys are overdone. Indigestion, indigestion!

8:30 a.m. Breakfast has raised my temperature. The necessity of wriggling into my swallowtail dawns upon me once again. At 8:45 I must be at the Consulate-General. "Boy!"—not here, of course. I must put it on without aid. Ah, it is on. A brush necessary. Where is it? *Under the dressing table!* Oh, what an effort; what puffing, what discomfort; but I have it. There are two specks on the collar, I see. Confound it! I have grazed the skin off two knuckles over a clumsy button. The brush flies over to the other side of the room. How I wish it had gone against the shins of my faithful attendant.

These stairs are farther apart than ever this morning. Good gracious! I nearly sprained my ankle! "*Yambo, bwana!*" the salaam of the natives, sounds in my ears as I pass along the streets. I dare not turn round to reply, because my collar is getting very limp, so I pretend not to hear the "yambos"—vendors of fried fish, ground nuts, cooked sweet potatoes, mangoes, bananas, &c., are all far more comfortable and happy than I am. They look wonderingly at me as I drag myself along, and I fancy I notice a sympathetic smile on some of their interesting faces; but I dare not turn round my head to make sure.

The Consulate reached at last. I drop into a chair at the invitation of the Consul-General, and talk, of course, about the weather—the subject ever uppermost in our minds so near the Equator. The monsoon, regarded so unfovourably by mariners, is looked upon by us in Zanzibar as our salvation from rapid evaporation; and just now there is a pleasant monsoon breeze coming into this room from seaward. It revives me.

My fellow-sufferers in black—*i.e.*, the British subjects—and the naval officers in full uniform drop in until the room is crowded. The signal is made for a start, and we all march towards the Sultan's Palace. I thought I was very badly off indeed in my evening dress, but when I see the officers of H.M.'s Navy buttoned up to their throats in blue cloth, laden with epaulets, gold lace, and heavy buttons, I am beginning to feel comparatively cool. Poor fellows, how they tug at their stiff collars, vainly trying to let in a little air. Their cocked hats are heavy, and their swords try to trip them. Umbrellas and sunshades do not form part of their uniforms, alas!

And so, headed by H.M.'s Political Agent and the bishop, we pass through the narrow streets of Zanzibar—sheltered from the sun here, exposed to his rays there, until at length we arrive within a stone's throw of the Palace. The Sultan's band strikes up "God save the Queen," and we uncover our heads naturally. The sun just here is particularly strong, and I think of the terrors of sunstroke. As the well-known notes from the brass instruments rend the air our procession passes by His Highness the Sultan, who stands in the Palace square and shakes hands with each of us. When this is done the Sultan leads the way up two flights of stairs, which are thickly guarded by Beloochee soldiers, until the reception room is reached. At one end of this room His Highness seats himself, placing H.M. Political Agent and Consul-General on his left, while the other visitors, or as many as can find room, sit in chairs arranged very closely together around the reception room. H.H. is a good-looking man, and his face wears a kind, intelligent expression. He converses with Her Majesty's representative upon general topics. The walls of this room are decorated with many large mirrors, while from the ceiling several massive and lustrous chandeliers hang. Clocks of various descriptions warn us of the fleetness of time from the niches so indispensable in Zanzibar houses. There are two life-sized paintings of His Highness which were, I believe, executed in England during his visit to the little land he thinks so much of.

Presently the sweetmeats are brought in on large trays, then sherbet, then coffee in glass and gold cups. After refreshments the otto of roses is passed round, and every visitor presents his handkerchief to be scented.

Those who have not found seats in the reception room are gone outside to sit on the verandah. From here they can see the Sultan's fifteen hundred soldiers assembled for the occasion in the square. They look exceedingly well. The visit lasts about twenty minutes; then His Highness again leads the way, and agains shakes hands with us outside his palace door. The band, which has been performing during the visit, strikes up "God save the Queen" once more, and thus amidst the strains of music and the beating of drums we leave the Sultan's palace and wend our ways homeward.

In my eagerness to divest myself of these clothes I walk briskly. I reach home panting. My shirt collar and cuffs are but wrecks of their former stiff selves. I shriek for my tub, and sink into it heartily wishing that I might live in it always.

3 p.m. A tray laden with sweetmeats such as I saw in the Palace is brought with H.H.'s compliments. I wish the pastry had been manufactured in Regent-street!

November, 1881. D.

MR. C. V. BOYS' ELECTRIC METERS.

In February, 1881, Mr. C. Vernon Boys described an interesting new integrating machine to the Physical Society, and he has recently applied its principle to the construction of several ingenious electric current and power meters, which are illustrated in the February number of the *Philosophical Magazine*, and for the working of which we believe a company has been organised. The new meters are based on what Mr. Boys calls the "tangent principle." This class of integrator depends on the formula for integration, which, in its geometrical application, finds a curve of which the steepness or the tangent of the inclination $\left(\text{i.e., } \frac{dy}{dx}\right)$ is equal to the ordinate of the given curve, or to the given function. The new integrator of Mr. Boys consists essentially of a small disc or wheel running along the surface of a drum or cylinder.

When the wheel runs straight along the drum parallel to its axis there is no rotation of the latter, but when the wheel is inclined to the axis the drum rotates, and the integral is represented by the amount of rotation. Continuous action is secured by giving the drum a reciprocating motion along its axis by means of a mangle-motion, so that when the wheel has travelled to one end of the cylinder it can travel back again. The new integrator is especially adapted for measuring forces which are either delicate or variable, because, unlike other integrators, the inertia and friction of the moving mass or wheel is so slight as to be quite inappreciable. It is applied by causing the varying force to be measured to vary in a corresponding manner the angle of inclination of the wheel to the axis of the rotating drum. Thus, by making the wheel very small and light, it can be made to integrate the strength of an electric current if the disc is inclined by the needle of a galvanometer in circuit, or it can be made to integrate the energy of an electric current which is the product of the strength of current and its electromotive force.

Two such meters are described in the *Phil. Mag.* by Mr. Boys. The first, which is designed as a current meter, is illustrated in

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Figs. 1 and 2; the second, which is intended as a power meter, is shown in Figs. 3 and 4. Fig. 1 is an end, and Fig. 2 a side view of the current meter, where M is a magnet which is deflected by the current flowing through a large coil of wire surrounding the instrument. The magnet M and the tangent wheel T are each fixed on the same spindle, which is vertical and made very light and delicate. The weight of the magnet produces the necessary pressure between the tangent wheel and the integrating cylinder, and, as the surface of each is convex, the friction

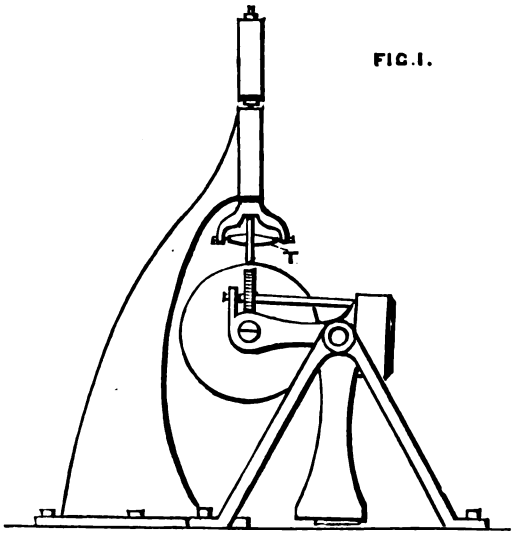

FIG. 1.

resisting the turning of the tangent wheel by the magnet is very small. The cylinder is supported in a bell-crank frame, which can be made to reciprocate along the wire W by means of the mangle-motion M M. The mangle-motion is actuated by clockwork, which may be wound up by the current itself if advisable. Such a current meter, like Edison's electrolytic meter, is a direction meter. If the current passes in one diretion it counts it positive; if in another, it counts it negative. A reverser actuated by a polarised armature could be employed to make the meter count as positive, a current passing either way, and so make it applicable to the case of alternating currents. Another kind of

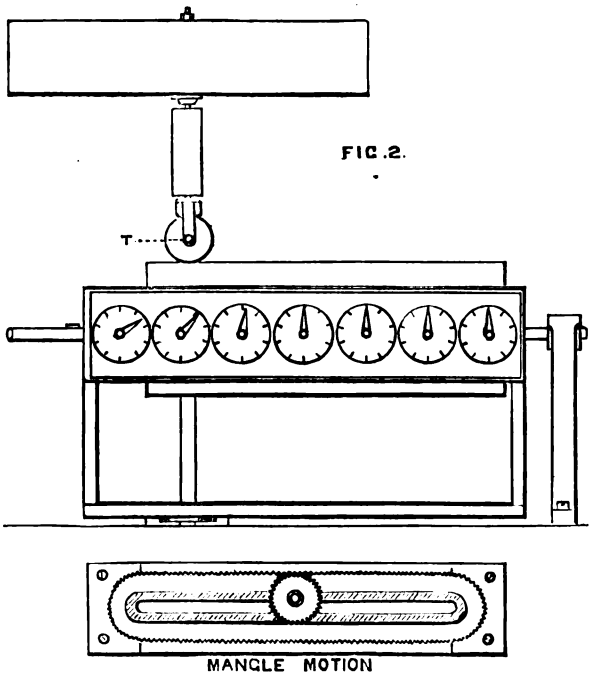

FIG. 2.

current-meter, which is, by its nature, independent of the direction of the meter, would, in Mr. Boys's opinion, be preferable to the magnetic-needle meter and reverser combined.

Figs. 3 and 4 represent an electric energy meter, where M M is the mangle-motion which causes the cylinder to reciprocate and bear alternately against the two tangent wheels T T. These wheels are mounted in a common swivelling-frame, which ordinarily is kept vertical by the weights, but which may also be inclined by a force due to any cause tending to turn the beam B. Now, the turning power of these weights varies as the sine of the inclination, while the turning power of a force acting downwards applied to the point P varies as the cosine of the inclination; therefore, the beam will set itself at such an angle that the tangent of the inclination is proportional to the force. If, therefore, the point P of the beam can be pulled downwards by a force which is proportional to the strength of the current, an electric meter will be the result. The beam is pulled by the following

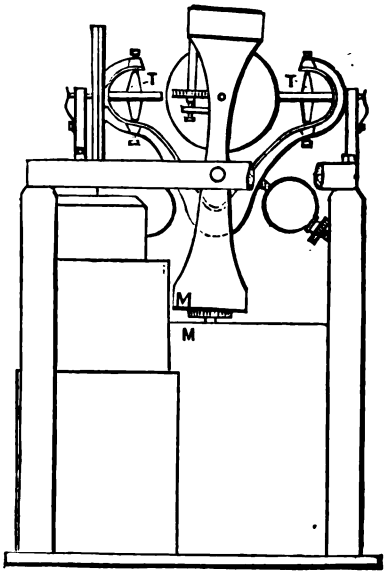

FIG. 3.

arrangement of solenoids:—If two wires, one conveying the main current and the other the derived current, are near one another, they will attract or repel one another with a force which is proportional to the product of the two currents—that is, to the energy being expended; but, if the wires are allowed to move, the force will depend also on the position. The wires ought, therefore, to be arranged so that the force exerted may be used to incline the tangent wheels, and yet be independent of their motion. Fig. 4 shows such an arrangement of solenoids. Outside are two fixed solenoids concentric with one another; and the main current is made to pass through each in the same direction. Inside is a solenoid made of a very great

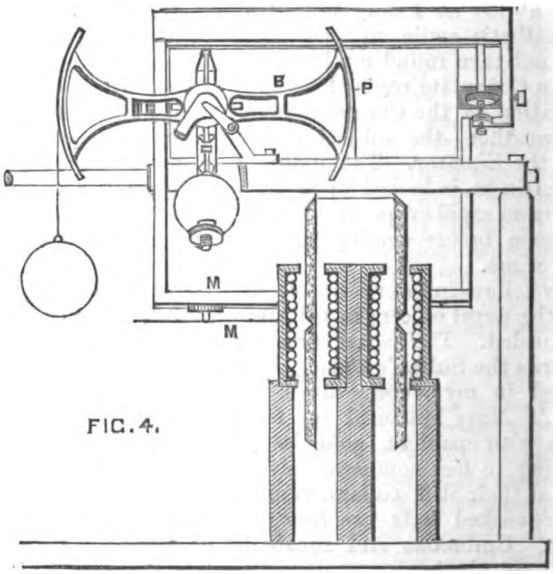

FIG. 4.

length of fine wire, preferably of aluminium silver, as suggested by Mr. Imray. The upper half is wound in one direction, and the lower half in the opposite direction, and the derived current is made to pass through it, so as to pass in the upper half in the same direction as the main current passes in the fixed solenoids, and in the lower half in the opposite direction. This solenoid is hung in the annular space between the fixed ones by a band passing over the arc of the beam B. The tubes within and without the fixed solenoids, and the rings above and below them, all darkened in the figure, are of iron, and may be used or not according as the current is weak or strong. But whether the

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tubes are retained or not the rings have the advantage of guiding the lines of forces across the poles of fixed solenoids at right angles to the wire of the movable coil; so, practically, the whole of the force developed tends to drag the solenoid downwards, instead of being partly spent, as before, in producing a stretching strain. Hence the movable solenoid can be made shorter than would be necessary were there no rings present. The tubes, having a higher coefficient of induction than air, merely serve to increase the number of lines of force rather than affect their distribution.

With such an arrangement the tangent of the inclination of the beam is proportional to the rate at which energy is being expended. But the speed of rotation of the cylinder is proportional to the tangent of the inclination; therefore, the number of turns of the cylinder given by the counting mechanism in the box over it is a measure of the total energy expended. The object in giving the movable solenoid an equal number of turns in opposite directions is to make it independent of the magnetic field in which it is placed, so that it can be used in workshops, or beside dynamo-electric machines. Also when used in houses it will be impossible for a householder to falsify its report by placing magnets near it.

LECTURES AT THE CRYSTAL PALACE.

SECOND LECTURE.

The second lecture of the course organised by the directors of the Crystal Palace was delivered on Wednesday evening in the concert room by Professor Sylvanus P. Thompson, of Bristol. The subject was announced as "Electric Currents: How to Generate them by Steam Power."

The lecturer opened his address by claiming the present development of electric science as a monument to the genius of Faraday. It was true the discovery of the electric light antedated Faraday's earliest work in electricity, but the electric light could never have proved practically or economically successful if some cheaper method of generating currents by mechanical power had not been invented. This mechanical production of electric currents was the great discovery of Faraday's life; and the modern magneto-electric and dynamo-electric generators were the instruments in which this discovery was embodied and applied.

The old glass frictional electric machine was now quite out of date, and the modern dynamo-electric machine had nothing to do with friction, but worked upon a self-sustaining magneto-electric principle. Sturgeon, Arago, and Henry had shown how to apply currents of electricity in making bars of iron into magnets by the simple process of winding the wire that carried the current in a spiral coil round the iron bar, which became a magnet so long as the current flowed. Faraday made the converse discovery that the motion of a magnet relatively to a coil of wire generated, or, as he termed it, "induced," a current of electricity in the coil; the current being a momentary one only, and lasting only while the magnet and coil were moving toward or from one another. The momentary current caused by mutual approach flowed, indeed, in the opposite direction through the wire coil to that generated by mutual recession.

In the machines used as generators there were special arrangements of many coils, fixed upon suitable frames and capable of being turned by a steam engine or other motor, whereby a large number of these momentary currents were generated in quick succession; there were also contrivances known as commutators to turn these numerous transient electric currents all into one channel, so as to produce a uniform and steady flow of electricity in the circuit. The lecturer discussed the various inventions which had been made to secure this end, beginning with the bobbins combined by Clarke and the simple longitudinal armature of Siemens.

The modern forms of armature might be grouped under three heads—the ring-armatures, as found in the generators of Pacinotti, Gramme, Bürgin, and Brush; the drum-armatures exemplified in the machines of Siemens (Hefner-Alteneck pattern) and Edison; and the pole armatures adopted in the generators of Lontin and Weston, and in some of the alternate-current machines of Wilde, Siemens, and Gramme. Drawings and diagrams of the principal forms of machine were thrown upon the screen. The only difference between the magneto-electric and the so-called dynamo-electric generators was that in the former the magnets were of hard steel permanently magnetised, while in the latter the magnets were of iron temporarily magnetised by passing the current generated by the machine itself round its own magnets in spiral coils. In both cases the reaction consequent on moving the coils past the magnets generated electric currents in the coils; and in both cases the energy required to maintain these currents was supplied by the motive power employed to drive the generator.

Hitherto steam engines had been almost exclusively employed for driving such generators, the lecturer mentioning the engines of Robey, Brotherhood, Hornsby, Gwynne, and Hodgson as being employed in the Palace in driving the generators for different systems of electric lighting. Great steadiness in the driving engine was indispensable for electric lighting. Edison had combined steam engine and dynamo togther in one enormous machine. Robey and Co. had applied an ingenious electric-action valve, but probably gas engines would in the future be found to supersede steam engines. One of Crossley's gas engines driving a Gramme generator was shown in action on the stage, and the lecturer referred to the extraordinary efficiency of the newer patterns of large gas engine, one of which, nominally of 16 horse-power, actually worked at 40 horse-power (indicated) with a consumption of only 17 cubic feet of gas per hour per horse-power. Where water power or tide power was available the cost of producing electric currents by dynamo-electric generators might be still further reduced, and the currents so generated might be distributed, not for electric lighting only, but for supplying motive power, and might be supplied in many places so cheaply as to abolish the use of steam engines, with their attendant nuisances of smoke and dirt and risk of explosion.

A CHEAP FORM OF VOLTAIC BATTERY.*

(Continued from page 237.)

The tendency of the caustic alkalis to absorb carbonic acid from the air renders it desirable, although not absolutely necessary, to keep the porous cell which contains the solution tightly covered. On the other hand, the iron portion of the battery should be exposed as freely to the air as possible to facilitate the escape of the hydrogen. These contrary conditions are rather vexatious, but by no means impossible of attainment. The most practicable mode of solving the difficulty appears to be the placing of the positive portion of the combination in an earthenware cell about seven inches in height, but porous only for four inches from its bottom, which porous cell is fitted with an air-tight stopper, through which the zinc rod is brought and terminated by a binding screw. The earthenware cell is placed in an iron can five inches in height and of a like diameter, and packed in firmly with turnings or borings. The earthenware cell having been filled with solution almost to overflowing, the air-tight stopper is fitted in, and the battery is ready for use. The advantages of this arrangement are the exclusion of carbonic acid from the caustic solution while the iron is left exposed to the air, the prevention of evaporation, and the preservation of the packing from too profuse a wetting. There being no air pressure on the surface of the solution in the earthenware cell, it can only percolate with extreme slowness, being opposed by the pressure of the air acting through the iron borings and the pores of the cell. The presence of carbonic acid in ordinary water renders it desirable to make the solution with distilled or newly-boiled water. If this is done, and the cell instantly closed with an air-tight stopper, the conditions necessary to secure the best results have been complied with. Instead of distilled or boiled, common water may be used if a portion of newly-slaked lime is added to the solution before closing the cell. For ordinary purposes, however, these precautions may be dispensed with.

Now, as to cost. The tinned iron can be used without detriment. The tin, being strongly electro-positive to iron, sets up a local action with the borings as soon as the solution reaches it, and, being small in quantity, is soon resolved into tin oxide without injury to the battery. The soldered joints of American preserve cans are but very little affected by the solution, and can be depended upon not to leak if tight in the first instance. Solders in which tin or zinc are present ought to be attacked, but copper and lead are but little acted upon. The joints of such cans are probably so carefully made in the first instance as to be mostly water-tight without the aid of solder. These cans may, therefore, be regarded as perfectly efficient, although so ridiculously cheap. The cost of one, including the borings, which are by no means scarce in Glasgow, may safely be put down at one farthing. The borings never need renewal, as they do not rust, and are not changed in any way by the action of the battery. The zinc may be of the commonest kind, as no local action of importance has been observed unless the caustic used is very impure. Amalgamation is therefore useless. Strips of common roofing-zinc rolled into cylinders answer perfectly well. The porous cell is the most expensive item, but this can be dispensed with by the use of diaphragms of canvas, or other fabric of vegetable origin. It must be remembered that the caustic alkalis destroy all animal tissues, so leather, bladders, &c., are not admissible. The author has tried cells of thin wood, such as willow-boxes, with success; but the earthenware is more permanent, and, in spite of its prime cost, probably the most satisfactory in the end. Such as the one before you can be procured wholesale at 2d. each. A diaphragm of some kind is absolutely necessary. Caustic soda, in a state of reasonable purity, is made in the neighbourhood of Glasgow, and can be obtained wholesale at a little over 1d. per lb. Whether this is sufficiently pure for long-continued action has, however, yet to be determined. To sum up the cost of one cell in its simplest form, we have

	s.	d.
Can and borings	0	0½
Porous cell	0	2
Zinc, say	0	1
Soda, 4oz.	0	0½
Soldered wires for connections	0	1
Labour	0	1½
Total	0	6

which is quite a liberal allowance.

The battery is, consequently, probably the cheapest ever devised, in proportion to its power and durability, when regarded in the light of prime cost. but it becomes even cheaper when it is considered that the chief product of its action is zinc oxide, known in the paint trade as zinc white, which is extensively used as a pigment and as a substitute for white lead generally. It can easily be recovered in an approximately pure state from the used-up battery. From the cell which rang the bell for a month 1.458 grains, or 3·04oz. troy, were recovered, the zinc consumed being 1,170·7 grains, or 2·44oz. troy. Some of it—one sixth of the quantity recovered—is on the table before you. Its price in the market ranges from 6d. to 1s. 6d. per lb., according to purity. As this is by no means a bad sample, containing only a very slight trace of iron, its value exceeds that of the zinc consumed. It has been said that voltaic batteries can never compete with dynamo machines, because the zinc used takes coal to reduce it from its ores to the metallic state, which coal would have produced the energy direct if burned in the furnace of a steam engine driving a dynamo. But if the product of the consumption of zinc in a voltaic battery can be made to defray the cost of the zinc, that oft-quoted argument somewhat loses its force. However that may be, it is pretty evident that the man who can buy, borrow, or—otherwise become possessed of a few old preserve cans, a corresponding number of porous cells, a quantity of iron borings, with a few pounds of caustic potash or soda, and who has an old zinc chimney to cut up, can conjure up and render subservient to his wants or his pleasure in many ways that mysterious, but beneficent, force which we know as electricity. He may, perhaps, even light his library on a small scale, or drive his wife's

* Paper read before the Philosophical Society of Glasgow on February 1st by Mr. Alfred R. Bennett, M.S.T.E. and E., engineer to Messrs. D. and G. Graham, Glasgow.

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sewing machine; and, after all, when the battery ceases to work he can take it to pieces and paint his house, or a part of it, with the products.

The battery, however, need not be made cheaply. It lends itself with equal facility to the taste of the sybarite as to the means of the working man. As before stated, nickel, cobalt, silver, gold, platinum, are all strongly electro-negative to zinc in caustic alkalis, and might all be used to good purpose. A golden goblet packed with half-sovereigns instead of a tinned can packed with iron borings would ring an electric bell or work a telephone admirably, as would also a silver chalice packed with sixpences; so it is obvious that refinement is possible in voltaic batteries as in everything else. It may be noted that copper also answers well instead of iron for a time, but a soluble salt of copper is gradually formed, which is precipitated upon, and stops the action of, the zinc. On the table are various forms of the battery. In some, the negative plate, consisting of an old file, an old knife, or a spiral of iron wire, is packed with the borings in a porous cell, the positive portion of the battery in such cases being in a glass or earthenware jar.

DISCUSSION ON MR. BENNETT'S PAPER.

Mr. J. T. BOTTOMLEY: It may be interesting to mention that Professor Joule some thirty years ago proposed the use of iron and zinc plates in caustic alkaline solutions, but the idea, I believe, never took practical shape. Certainly Mr. Bennett's battery is a great improvement on the form suggested by Professor Joule, and will, I have no doubt, take the place of the Leclanché for many purposes. I may say that Mr. Bennett sent me three of his iron cells to test. The results I arrived at agreed well with his own, that is to say, I found the electromotive force of the new battery to be about 1·38 volts.

Dr. WALLACE: I should like to ask whether the packing of iron borings is absolutely necessary, and how far they should be immersed in the solution?

Mr. BENNETT: The battery is of no practical value without the packing. The borings should be well damped, but not covered by the solution. If covered the battery is still useful, but the electromotive force is not so high nor the constancy so great.

After some further remarks by other members,

The PRESIDENT said that the able and interesting paper they had just heard read threw a new light upon voltaic batteries, at least as far as he was concerned. He had hitherto considered them expensive luxuries, but now perceived that they need be so no longer.

A vote of thanks to Mr. Bennett for his communication to the society was then proposed and carried.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

At the meeting of this Society, held at the Institution of Civil Engineers, on 23rd February, Lieut.-Col. Webber in the chair, a brief report was read, signed by Mr. Latimer Clark and Mr. W. H Preece, announcing the completion of the labours of the Lightning Rod Conference, which was commenced in 1878, and at which the two gentlemen just named had represented this Society. The conference had held twenty-nine meetings, and had finally arrived at unanimous decisions, which would shortly be printed for public use. Votes of thanks were then conveyed to Messrs. Clark and Preece for the part they had taken in this work.

A paper by Mr. R. VON FISCHER TREUENFELD on Siemens's "System of Railway Gong Signalling" was then read by the secretary, Mr. Treuenfeld himself assisting in explaining the diagrams with which the paper was amply illustrated, and also in exemplifying the system in actual operation, some very admirable samples of the apparatus being erected in the room. The system which Mr. Treuenfeld brought before the Society's notice was, he admitted, of very little utility in this country; but since the year 1847 it had been in use on the continent, where it had spread and become general over an enormous mileage of railroad. Level crossings, which would be exceedingly dangerous in this thickly-populated country, and which were almost wholly forbidden, were exceedingly common in other countries. Here it was considered cheaper in the long run to erect bridges than to incur the expense and risk of multiplying level crossings and gates. But, elsewhere in agricultural districts, intersected by numerous roads, it was found that to erect cottages at these places, where the line repairers could live and their families attend to the gates, was both economical and safe. In all probability there were many districts, even in Great Britain and Ireland, where such a system would be equally applicable. Certainly it was so to our Colonial and Indian railroads, and on this account Mr. Treuenfeld had thought it worth while to describe the gong signalling system to the Society, whose members were connected with electrical signalling all over the world. The colonies, where single lines were common, had followed the expensive example of the mother country, even when more homely methods of signalling would have served them quite as well; and the gong system had some special advantages which rendered it, when otherwise admissible, a very superior safeguard against railway accidents.

These gongs can be heard 500 yards off, and serve to attract the attendant when engaged working in the fields or on the line. They are generally erected on the roof of the cottage, the clockwork with which they are connected being under cover inside. The gong itself is of cast metal, of dome-like shape, from 6in. to 24in. in diameter, the hammer being underneath. The sound resembles that of a small church bell when rapidly tolled. The hammer is, of course, connected with the clockwork, which has to be wound up occasionally, and which is set going by the action of an electro-magnet similar to that of an ordinary electric alarum. By means of concerted signals, indicated by the number of beats or series of beats, the station from which a train has started informs all the gong signalling houses between that and the next station of the fact, and of the kind of train that is coming. Where needful the gong is supplemented by a morse instrument, which, on a given signal, can be inserted in the circuit by depressing a foot lever under the table on which the instrument is placed. Battery power is then employed, the action of the lever serving this purpose as well; but the same wire is used as that which rings the gongs—this at least is frequently the case, though a second wire is recommended.

For the ringing of the gongs, or rather for the releasing of the detent connected with the hammer, it was found that battery power often failed, partly from variation in the battery, partly through atmospheric changes; so that the adjustments had to be frequently altered, which, when unskilled persons are in charge, is a serious difficulty. Magneto currents were therefore at length universally substituted, and these have worked admirably, one useful feature of the magneto inductor employed being that alternating currents are transmitted, and as nothing but an alternating current would start the clockwork, no atmospheric or other disturbance would cause a working signal to intrude itself. The inductor is composed of twelve permanent magnets, between which an armature revolves, developing two currents in opposite directions. It has two keys, which are used respectively for the up and down line series of gongs. An ingenious device at each of the gong signal stations enables the gatekeeper to send for help to the nearest railway station. Keys of different lengths are provided, the mere insertion of which at the gong stations causes signals corresponding with the particular key used to reach the railway station, together with the "number" of the gong station from which the signal has been sent. Mr. Treuenfeld's paper concluded with some interesting statistics showing the extent to which the German gong system is in use in various parts of the world.

A discussion ensued in which Mr. Spagnoletti and Mr. W. H. Preece took part, the one explaining the signalling system in operation on the Great Western Railway, the other giving some account of the history of the block system of electrical signalling in this country, both gentlemen concurring in the opinion that the one defect of that system was the difference of code signals adopted by different railway companies, and in strongly recommending a common agreement among them in this particular.

A vote of thanks to Mr. Treuenfeld for his interesting paper concluded the proceedings.

PHYSICAL SOCIETY.—FEB. 25.

Professor G. C. Foster in the Chair.

Professor W. E. AYRTON, F.R.S., read a Paper on "Faure's Accumulator," giving results of experiments made by him and Professor Perry on the efficiency, storing power, and durability of the battery. The efficiency was got by measuring the power put in and comparing it with that taken out by means of Perry and Ayrton's voltameter and ammeter. The authors found that the cell has great resuscitating power if left insulated after all the current appears to have been discharged. Care had to be taken to see that the cell was quite discharged, by letting it stand on open circuit for intervals, and discharging between whiles. When this was done they found that the total loss for charges up to one million foot pounds need not be greater than 18 per cent. With slower charges they got a loss of only 10 per cent. As to the storage, a mean current of 18 amperes gave, after 18 hours' discharge (six hours on three consecutive days), 1,440,000 foot lbs. of work, equivalent to 1 horse-power in 43 minutes. The cell contained 81lb. of red lead, thus making a capacity of about 18,000 foot lbs. per lb. of red lead. The cell showed no deterioration after two months of work. Professor Ayrton then described a new form of his dispersion photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the author. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting paper by the two lights simultaneously. A sperm candle is used on the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the same part of its surface whatever angle it is placed at, and thus the power of an electric light can be accurately given for every angle along which the ray travels from the lamp. Observations are taken through red and green glasses to get a better measure of the power of the light. Professor Ayrton has found that ordinary air absorbs the green rays of the electric light very strongly, and hence, in order to get a proper test of an electric lamp, the photometer should not be far from the light. The new dispersion photometer shown is the only one admitting of this precaution.—Mr. Shoolbred stated that he had found from experiment that the carbons of the Swan and Maxim incandescent lamp bore a much higher current without breaking when fed from a Faure accumulator than from a dynamo-electric machine.—Professor Ayrton corroborated this statement, and said that he had obtained a light of 800 candles from a Maxim lamp fed by an accumulator.

Professor SYLVANUS THOMPSON then read a paper on "The Electric Resistance of Carbon under Pressure." It was generally stated that the resistance of carbon diminished under pressure, but he had found, from recent experiments, that the diminution observed was really due to the contact between the electrodes and the carbon. Under pressure there are more points of contact between the metal and carbon than without pressure. The result was an important one, bearing on the action of the carbon relay, rheostat, and microphone transmitter.

Professor AYRTON pointed out that, as carbon apparently diminished in resistance under a rise of temperature, this would seem to indicate it as a compound substance, since only simple substances seemed to increase in resistance with rise of temperature.

Professor GUTHRIE recalled that Dr. Moser had suggested that the alterations of the resistance of selenium under light was an effect of contact.

A paper by Mr. G. GORE, "On the Influence of the Form of Conductors on Electric Conductive Resistance" was read. His experiments were designed to show whether there was a difference of resistance in certain liquid conductors under the positive and negative current. None was discovered.

Dr. HOPKINSON, F.R.S., read a paper "On the Refractive Index and Specific Inductive Capacity of Transparent Insulating Media." He inferred, from tried experiments and the electro-magnetic theory, that glass had a high refractive index for rays of very long wave length.

Dr. J. H. GLADSTONE suggested that the point should be tested by experiment, and that the method of photographing the red rays might be employed.

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TELEGRAPH CONSTRUTION AND MAINTENANCE COMPANY (LIMITED).

The eighteenth ordinary meeting of the shareholders of the above Company was held on the 28th ult. at the offices, 38, Old Broad-street, under the presidency of Sir Daniel Gooch, Bart., M.P.

The SECRETARY (Mr. E. Dickens) read the notice convening the meeting, and the minutes of the last two meetings, which were approved by the present meeting. The report, which has been published in *The Electrician*, was taken as read.

The CHAIRMAN: I will merely call your attention to a few of the figures, which, I daresay, you have in your minds. The accounts show that the net profit during last year was £72,299, and we brought forward from the previous year £77,735, making together £150,000 in round figures for disposal. We shall have paid a dividend of 20 per cent. during the year, leaving a balance for next year of £60,394. I hope you will consider that a very satisfactory result for the year's working. The work we have been doing during the past year has not been so large as in some former years. We made for the Western and Brazilian Company 200 miles of cable, which the "Kangaroo" sailed two days ago to lay. We have also repaired the French Atlantic cable during the year. For the Eastern Extension Company we laid 537 miles of cable between Singapore and Batavia, and we also picked up some of the old cable—as much as we could get. Paragraph E refers to the shore ends of the cable between Emden and Valentia, and 840 miles of the intermediate portion of the cable we are now making, and it will be laid in the course of April next. Between Corfu and Trieste we have laid 550 miles, and we have completed all our contracts with the South African Company—all the buildings and matters connected with the land portion. We are also now engaged in the repair of the German Union line. The report states that all our machinery, ships, &c., are in very good order. The ships we have are the "Scotia," which is about to go out with this 840 miles of cable that I have referred to; the "Seine" is on her way home—she has been laying the cable between Singapore and Batavia; the "Kangaroo" has left with the piece of cable for the Western and Brazilian Company, and the "Calabria" has been twice employed by the Government in carrying troops, I believe to their perfect satisfaction. The accounts are set forth in full detail, and I shall be very glad to answer any question with respect to the figures if any shareholder wishes for any further information. I don't know that I have anything further to say. I hope we shall be able to go on with the same prosperity as has hitherto attached to the Company. I now move, "That the report and accounts of the directors to the 31st of December, 1881, submitted to this meeting, be and the same are hereby received and adopted, and that a dividend of 36s. per share in addition to the 12s. per share in interim dividend paid on 30th June, 1881, be paid on all the shares of the Company for the year ended December 31, 1881, and that such dividend be paid free of income-tax."

Sir GEORGE ELLIOT, Bart., M.P., having seconded the motion,

Mr. WAKEFIELD stated that he held a tolerable stake in the Company, and he knew that it would be edifying to him, and perhaps it would be to some of the other shareholders, to have a few words from the chairman of encouragement for the future. They were all aware that at one time there was a great fall in their shares. However much they might in such an excellent concern as theirs set aside Stock Exchange rumours, yet at the same time some very old shareholders had been frightened into parting with their shares. There was at the time mentioned a fall of £7 or £8 a share. He was quite at a loss, and so were those with whom he conversed on the subject, to understand how this had occurred, but the report was that they were getting not nearly as much work beforehand as in the previous half-years. He was quite sure that that was not the fault of the directors or of those who managed this concern, for they all knew that there was a great deal of energy displayed in connection with the business of the Company by those to whom its affairs were entrusted. Still, it must strike them all, he thought, that a time would arrive when there would be less work in the laying of telegraphs, because the lines might be laid to most places and would not break sufficiently often for the purposes of the Company to replace them. He would, therefore, ask how they stood with regard to their future—whether they had a prospect of much more to do? Of course this had been a prosperous Company, and that there would be oppcsition was to be expected; and in one quarter they knew that they were pressed a great deal by people who were undertaking work which this Company could not see could be profitable. He happened to hear every now and then that that company thought they would be able to manufacture much cheaper than this Company. Telegraph lines could now be laid at much less expense, and a smaller and less expensive cable would do. He should be very glad to hear some expression as to whether this Company were taking up other business. Nothing was talked of now but the electric light and telephones, and supposing that the Company could not get sufficient work in telegraphy to employ them, could this other work be taken by them?

The CHAIRMAN: It would not be wise for me to prophecy the future of the Company. It is true that a great many cables have been laid, but I think experience has shown hitherto that a great many cables are yet to be laid, and we have every reason to believe that we shall get our fair share of whatever is to be done. A business of this kind, however, like other businesses, must fluctuate, and we have had times when we have been busy, and times when we have been quieter, in our past history, and I do not know that we shall not be subject to that experience again. The opposition you spoke of is not new, but has been in existence for several years. We have fought our way through it in the past, and I hope that we shall do so in the future. Our cables that have been laid have given every satisfaction to the companies who employed us, and we certainly have been fortunate in the skill of our staff in the laying of them, without any delays or accidents, and with our own ships. I don't know that the same can be said of all the cables that have been laid. As to other business, we are doing a good deal of business beyond laying cables. We have large works where gutta percha manufacture is carried on, and we are also constructing a considerable quantity of the lines for the electric light. I have no doubt that that will cause a largish consumption of our peculiar manufacture, the gutta percha wire. It has done so now. As to the future of cable laying, I think you are all as well able as I, perhaps better, to form an opinion. You may rely that, whatever work is to be done, we shall do our best to secure a fair portion of it. Cables are constructed now much cheaper than formerly, and we can construct them much cheaper now from the experience and knowledge we have gained by a great many years of work. We can guarantee our cables being efficient and good when they are laid, and we must rely on that fact as regards future work. Mr. Wakefield spoke of lighter cables being made, but the feeling among those who have the management of cables, or cable companies, is rather in the other direction—that the cables have been made too light. The strength of a cable now is considered a very important feature, and they are being laid stronger now rather than lighter; and, as I have said, it is the feeling of cable companies that they should be stronger.

He then submitted the resolution in the usual manner, and it was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. PHILIP RAWSON, Sir George Elliot, Bart., M.P., was re-elected a director, as was also Mr. Rawson, on the motion of the CHAIRMAN, seconded by Vice-Admiral Sir GEORGE H. RICHARDS, C.B., F.R.S. (the managing director of the Company).

Mr. WILLIAM ABBOTT, in moving the reappointment as an auditor of Mr. John Gane, alluded to Mr. Wakefield's remarks as to the future working of the Company, and observed that the answer of the chairman was exactly the same answer which he (Mr. Abbott) had received on several occasions from Sir Daniel Gooch, whom he really commended for his reticence in not going into particulars. He had, however, generally found in this Company that, despite the announcement at the beginning of the year that the Company had no work, the year had generally proved very profitable. He had not the slightest doubt as to the future of the Company, more especially as the suggestion which he had thrown out that the directors should identify the Company in every way with electricity was likely to be entertained.

A SHAREHOLDER seconded the motion, which was carried.

On the motion of Mr. ABBOTT, seconded by Mr. WAKEFIELD, Mr. James Glegg (of the firm of Quilter, Ball, and Co.) was then appointed the other auditor.

Mr. WAKEFIELD then moved, and Mr. ABBOTT seconded a vote of thanks to the chairman and directors, and it was carried unanimously.

The CHAIRMAN: We are much obliged to you gentlemen, and we shall do our best for you. He then referred to some interest which had not been claimed. It was at the bankers, and the directors would be glad if the parties to whom it belonged would claim it.

The meeting then separated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES MARCH 1.		BUSINESS DONE WEEK ENDING MARCH 1. Highest.	Lowest
Anglo-American	47¼,	48¼	48¼	47¼
Do. Preferred	75½,	76½	78	76
Do. Deferred	19,	20	20	18½
Brazil Submarine	11,	11¼	11¼	11
Cuba	8¼,	9	—	—
Do. Preference	15½,	16½	—	—
Direct Spanish	5¼,	5¾	—	—
Do. Preference	14¼,	15¼	15¼	15¼
Direct United States Cable	9½,	10½	10½	10
Eastern Telegraph	9¾,	10¼	10¼	9 15-16
Do. 6 per Cent. Preference	12¼,	12¾	12¼	12¼
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	10¼,	11¼	—	—
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust Company	5¼,	6¼	6 1-16	6
Do. Preference	11½,	12½	12½	12
Great Northern	11½,	12	11¾	11¼
Indo-European	28,	29	28¼	28¼
Mediterranean Extension	2¼,	3	—	—
Do. Preference	9¼,	9¾	9¼	9¼
Reuter's	12½,	13	—	—
Submarine	270,	280	—	—
West India and Panama	1½,	1¾	1¾	1¼
Do. 1st Preference	7¼,	8	7 11-16	7 11-16
Western Brazilian	8¼,	8½	8¼	8¼
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	104,	107	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1¾	1¾	1 3-16
Oriental	1½,	1¾	—	—
United Telephone	13,	13¼	13¼	12¼

ELECTRIC LIGHT.

Electric Light and Power	⅞,	1	15-16	⅞
Anglo-American Brush	8¼,	9	8¾	8

TRAFFIC RECEIPTS FOR FEBRUARY, 1882.

COMPANIES.	Feb., 1882.	Feb., 1881.	Incrse.	Decres
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	27,473	28,021	—	548
Eastern Telegraph Company	44,046	46,463	—	2,417
Great Northern Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

991. GALVANIC BATTERIES, *G. F. Redfern.*—*8th March*, 1881.—(*A communication from S. Marcus.*)—(*Not proceeded with.*) 2*d*.

The object of this invention is to do away with the porous pots of the ordinary battery, and to construct a permanent cell equally applicable for military and domestic uses.

1030. APPLIANCES IN CONNECTION WITH MUSICAL INSTRUMENTS FOR REPRODUCING TUNES PLAYED THEREON, *T. Paterson.*—*10th March*, 1881. 6*d*.

This consists in electrical and mechanical arrangements by which the action of a pianoforte, organ, or other keyed instrument, when played upon, produces such a modification of a mechanism combined with it that a piece of music once played upon it may at any time be repeated by the automatic mechanism set in motion by electricity, clockwork, or other means.

1474. APPARATUS FOR LAYING UNDERGROUND TELEGRAPHIC, &c., CONDUCTORS, *J. C. Mewburn.* — *5th April*, 1881. — (*Not proceeded with*).—*A communication from J. Bourdin and General S. I. de Maltzoff.*) 2*d*.

This invention consists of a carriage carrying a reel on which the conductor is wound, and a kind of ploughshare, which makes a channel for the conductor, the latter running through a hole in the former as it advances, and coming out at the rear in the channel formed. A flattening roller is provided behind the share to replace the soil, and in front is a rotary coulter which prepares the furrow in which the share travels.

1624. IMPROVEMENTS IN ELECTRIC TELEGRAPHS, *A. Muirhead and H. A. C. Saunders.*—*13th April*, 1881. 6*d*.

To facilitate the reception of messages on long submarine cable circuits, the inventors employ a double telephonic repeater in connection with the suspended coil or magnet of the receiving instruments; this repeater consists of three independent coils, the middle one suspended and movable between the other two. It is connected to the movable coil of a recorder and responds to the fluctuations of the cable current in the latter. The other two coils are fixed and connected to two separate telephones. A rapid series of currents from a battery is caused to pass through the suspended coil. Sound is thus produced in the telephones varying in intensity with the proximity of the suspended coil to the fixed coils. The operator placing a telephone to each ear reads by sound the message transmitted. For automatic translation between submarine cables the inventors employ an arrangement of selenium cells, extending like the scale of a reflecting galvanometer in connection with two relays which are placed in a closed circuit with the series of selenium cells. The movable index of the receiving instrument controls a beam of light or heat, and by its motion determines the number of selenium cells influenced by the beam. An electromotive force is thus created in the bands of cells which will be proportional to the amount of movement of the index. When the rate of signalling is such that minor signals tend to run together, they are automatically reproduced by mechanism in retransmission.

1745. IMPROVEMENTS IN ELECTRICAL BATTERIES, *C. D. Abel*, *22nd April*, 1881.—(*A communication from P. Jablochkoff.*—(*Not proceeded with.*) 2*d*.

This relates to an accumulator of electricity which operates on the principle of secondary batteries, but differs from them in its construction and mode of action. It consists in rendering the electrodes more apt to become polarised by covering them with some sort of hydrocarbon or other oil. This oil operates like the oily coatings of static condensers of electricity, and retains the charge of electricity, in addition to the chemical action of polarisation which is going on.

1762. IMPROVEMENTS IN THE PREPARATION OF MATERIALS TO BE EMPLOYED FOR THE PURPOSES OF ELECTRIC INSULATION, *J. A. Fleming.*—*23rd April*, 1881. 6*d*.

In place of vulcanite, ebonite, or glass, which are not easily workable with tools, the inventor makes an insulator of wood, so treated as to remove all water and acids from it, and then impregnated with melted paraffine wax, which is forced into it under pressure. The wax solidifies in the fibre, and converts the wood into a nearly perfect conductor. The apparatus used is of the usual type for such purposes. The insulator thus obtained is easily workable by tools.

1923. SEPARATING IRON FROM CHARCOAL, &c., *D. M'Eachran.*—*4th May*, 1881. 6*d*.

The substance containing the iron, and from which the iron is to be separated, is caused to pass between the poles of magnets, or between magnetised bars or surfaces, which are adjusted or adjustable nearer to or further from each other, according to the state of the material or the quantity of iron contained therein, or according to the state in which the iron is contained therein.

2110. REGULATING THE WORKING OF VACUUM PANS APPLICABLE FOR SUGAR BOILING, &c., *A. Watt, Liverpool.*—*14th May*, 1881. 1*s*.

Electro-magnetic valves are used for admitting the various fluids into the vacuum pans and condensers, these being all of a similar type, but each controlled partially according to its position or use by electrical thermometers or vacuum gauges, or both, the connection between these valves and the thermometers or gauges being so arranged that the alteration of the position of the mercury will either cause the flow or stop the flow of a current of electricity through the electro-magnet controlling the valve, and so cause the valve to open or shut as required, this current of electricity proceeding from a dynamo-electro machine or other sufficiently powerful generator of electricity.

2212. DYNAMO-ELECTRIC MACHINES, *C. A. Barlow, London.*—*20th May*, 1881.—(*A communication from A. de Meritens.*)—(*Not proceeded with.*) 2*d*.

This relates to the use of straight magnets, provided with an armature at one set of poles, these to form a horseshoe magnet.

2215. IMPROVEMENTS IN COUPLINGS FOR ELECTRICAL CONDUCTORS, *P. R. Allen, Southwark.*—*20th May*, 1881. 6*d*.

This invention refers to the adaptation of existing vacuum or other brake couplings on railway trains, for forming connections in wires used for lighting or other purposes in the said trains. The couplings are made to carry the contact points of the conductor attached to each carriage, the contact being made by the bodies of the couplings themselves, or by other devices, such as plungers. To keep the contacts clean and free from dust, &c., they are made to rub over a rough surface of some kind every time the coupling is connected or disconnected. The specification is accompanied by drawings showing the different form of coupling adapted to the various rake systems.

2264. CABLES OR CONDUCTORS FOR ELECTRICAL CURRENTS, *W. L. Barney, London.*—*24th May*, 1881.—(*Not proceeded with.*) 4*d*.

The conductor is insulated, the whole covered with a conducting tube or conducting material in some shape.

2308. SIGNALLING APPARATUS FOR RAILWAYS, *J. King. Pinxton.*—*26th May*, 1881. 10*d*.

This relates to the construction and employment of three several separate modifications of apparatus in conjunction with an electric current or currents for signalling upon railways.

2369. A NEW OR IMPROVED ELECTRIC LAMP WITH AUTOMATIC REGULATION, &c., *S. Cohné, London.*—*30th May*, 1881. 4*d*.

The inventor uses a cylinder filled with glycerine which contains a float. This latter supports two double jacks secured to a top and bottom cross-bar, forming a parallelogram, the frame being worked in vertical pinions. One carbon is fixed in each cross-bar. A telescopic sliding tube is fixed on each cross-bar to establish the circuit without interfering with the sliding of the cross-bars. In the support of the glycerine holder is fixed a catch, and opposite to it a wheel actuated by a cam attached to the armature of a neighbouring electro-magnet. When the current enters the electro-magnet it attracts the armature, and with the cam pushing the wheel carrying the catch downwards, thus separating the carbons, and forming the arc. The lamp is regulated by the tendency of the carbons to approach one another when the arc has increased so as to weaken the current through the armature.

2416. A MAGNETO-ELECTRIC MACHINE, *F. Wolff.* *1st June*, 1881.—(*A communication from C. P. Jüngersen and L. V. Lorenz, Copenhagen.*) This machine is somewhat similar to the Gramme. It has an outer electro-magnet, and an annular armature with wire coil sections, and rotating between the poles of the electro-magnet. Powerful action is obtained by means of a central electro-magnet inside the annular armature; this electro-magnet is of the shape of two bar magnets placed crosswise, and having north and south poles respectively, united by a polepiece: it has also a central gudgeon, which is screwed into a standard, so that the north and south pole of the inner electro-magnet are opposite the north and south pole of the outer one. To steady the armature in its bearing, unmagnetic rings project from it; one of these has a central annular steel boss, which fits freely round the gudgeon, and a projection which works in the bearing, and the other is fastened to the armature spindle. The armature is made up of a number of insulated rings, held together by bolts. The spokes uniting the ring at the gudgeon end with its boss are chamfered off on the edges, and have little wings, so that by the rotation of the armature an air current is introduced, preventing any heating. The outer electro-magnet consists of two electro-magnets connected by the bed-plate of the machine; the two each resemble the half of a horseshoe. This machine has been illustrated and described in the *Engineer*.

2491. MANUFACTURE OF TIN-PLATE, &c., *W. Elmore, London.*—*8th June*, 1881. 6*d*.

This relates to the process for the manufacture, tinning, and surfacing of tin plates, and for tinning metal articles, consisting of the employment of the tin solutions, the tin anodes, and the electric current, and in combination with the cathode holder or dipping frame of the plating tank.

2542. IMPROVEMENTS IN ELECTRICAL INSULATED WIRES AND CONDUCTORS, AND IN THE MEANS OF INSULATION OF THE SAME, *S. J. Mackie, London.*—*11th June*, 1881. 4*d*.

This invention consists in covering the wires with a flat covering of jute, hemp, or other yarn, and saturating the same with insulating materials, so that both jute and insulating material become combined, and form a practically homogeneous substance. The outer covering may be waterproofed by gelatine, combined with bichromate of potash or other means. The insulating material may be gutta percha, Stockholm tar, and resin in equal weights, mixed with powdered glass to secure solidification.

2554. IMPROVEMENTS IN APPARATUS FOR RECEIVING AND TRANSMITTING AUDIBLE SIGNALS BY MEANS OF ELECTRICITY, *A. F. St. George.*—*13th June*, 1881.—(*Not proceeded with.*) 2*d*.

This invention consists in reproduction of audible signals by means of a vibrating disc, in connection with an electro-magnet surrounded by insulated wires. When undulating currents are sent through these wires corresponding vibrations of the disc produce audible signals.

2607. IMPROVEMENTS IN ELECTRIC BELLS, &c., *W. P. Granville.*—*15th June*, 1881.—(*Not proceeded with.*) 2*d*.

In place of the ordinary armature attached to a hammer, by the attraction of which the bell is rung, the inventor so constructs the electro-magnet that one of its poles is made capable of movement to and from the other pole; the movable pole operating the hammer.

2848. IMPROVEMENTS IN THE TREATMENT OF CARBON FOR ELECTRIC LIGHTING, AND OTHER PURPOSES, *J. G. Lorrain, London.*—*29th June*, 1881. 4*d*.

This invention consists in improving the carbons by impregnating or coating them with precipitated carbon, so as to fill up the instertices, the carbons being first saturated with some hydrocarbon, which is then decomposed by the action of chlorine gas.

250,590. METHOD OF MAKING IRIDIUM-TIPPED METALLIC RODS, *Samuel W. Skinner and William M. Thomas, Cincinnati, Ohio.*—*Filed July 21st*, 1881.

Claim.—(1) The process of manufacturing an iridium-tipped metallic rod, which consists in charging with granulated iridium a cup-formed carbon positive electrode and bringing the same, while under the action of galvanic discharge, into repeated contact with the tip of a rod of other metal, substantially as set forth. (2) The process of manufacturing an iridium-tipped metallic rod, which consists in charging with granulated iridium a cup-formed carbon positive electrode and bringing the same, while under the action of galvanic discharge, into repeated contact with the tip of a rod of other metal, the rod proper being then enveloped with a re-enforce of the same or different metal, substantially as set forth.

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SLIP

ATHENÆUM CLUB.—Mr. William Crookes, F.R.S., has been elected a member of this club.

DIVIDEND.—The German Union Telegraph Company have declared a dividend of 8⅔ per cent. for 1881.

THE EDISON LIGHT.—We understand that Messrs. Robey have introduced this light into their extensive works.

THE CENTRAL TELEGRAPH STATION.—According to the *Daily Chronicle* a new story is to be added to this building.

BRAZILIAN SUBMARINE COMPANY.—The traffic receipts of this company for the week ending the 3rd inst. amounted to £3,950.

ELECTRIC LIGHT IN PORTLAND (AMERICA).—It is stated that a hotel, city building, and many stores in this city are now lighted by electricity.

ROYAL INSTITUTION.—Yesterday (Friday) evening a paper was to have been read at this institution by Mr. Swan on "Electric Lighting by Incandescence."

NEW ELECTRIC LIGHT COMPANY.—A company, with a capital of 100,000 dollars, has been organised to introduce the electric light at Columbus, Galveston State, U.S.A.

RAPID TELEGRAPHY.—It is stated that the Rapid Telegraph Company succeeded, in a recent trial, in sending over a single wire, from New York to Boston, 1,500 words in a minute.

ROYAL AVENUE THEATRE.—Portions of this theatre, which was to have been opened to-day, will be lighted by the Compagnie Générale d'Electricité with the Jablochkoff system.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February, 1882, amounted to £2,109, against £1,876 for the corresponding period of last year.

THE MONTE VIDEAN AND BRAZILIAN TELEGRAPH COMPANY.—The next ordinary meeting of this company will be held at No. 9, King's Arms-yard, Moorgate-street, E.C., on the 16th inst., at 12:30.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended Feb. 28 amounted to £2,551, against £2,018 in the corresponding period of 1881.

POST OFFICE TELEGRAPHS.—The estimated revenue for 1881-82 was £1,600,000. The total receipts into the Exchequer from April 1, 1881, to March 4, 1882, were £1,505,000, and in 1880-81 £1,475,000.

ELECTRIC LIGHT IN SAN FRANCISCO.—The San Francisco Board of Fire Underwriters have, it is said, adopted similar rules relating to the introduction of electric light wires, &c., to those adopted by the New York Board.

THE FORTH CABLE.—The connection of the land wires with the new cable crossing the Forth at Aberdour was completed and telegraphic communication re-established on Wednesday week. The cable was broken in October last.

GALES IN SCOTLAND.—A severe north-westerly gale in the north of Scotland on Monday last occasioned extensive damage to the telegraph lines from Aberdeen northwards, many poles being blown down and communication stopped.

SOUTH AFRICAN TELEGRAPHS.—The revenue derived from the telegraphs by Cape Colony during December last amounted to £5,540 8s. 6d., against £4,342 18s. 8d. for the same period of last year, being an increase of £1,197 9s. 10d.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 3, 1882, were £2,785, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for February amounted to £17,000, and for the period from 1st January to 28th February to £33,960, against £34,408 for the corresponding months of 1881, and £31,488 in 1880.

ELECTRIC LIGHT IN MINNEAPOLIS.—An American contemporary says that the Mayor of Minneapolis, Minnesota, U.S.A., has vetoed an ordinance passed by the city council providing for lighting the streets by electricity owing to the fire risks attaching to the erection of the wires.

SOUTH AUSTRALIAN TELEGRAPHS.—The Post Office telegraph returns for the colony of South Australia show that during 1881 the local messages amounted to close on half a million, the intercolonial to 137,630, and the cable messages to 2,636. Six new stations were opened during the year.

DOMESTIC ELECTRIC LIGHTING COMPANY.—This Company's Exhibition was opened at the Victoria Cross Gallery Rooms of the Crystal Palace on Wednesday night, when the electric light was shown as applicable to ordinary domestic uses. We shall refer to this Company's exhibits at greater length in a future number.

INCANDESCENT LIGHTS ON SHIPBOARD.—The ss. "Antonio Lopez," built by Messrs. William Denny Bros., of Glasgow, for the Transatlantic Company, of Barcelona, which was recently launched, has been fitted with Swan incandescent lamps, seventy of which are distributed throughout the saloons and passages.

POST OFFICE APPOINTMENTS.—Mr. C. H. B. Patey, Assistant Secretary for Telegraphs at the Post Office, has been promoted to the office of third secretary, rendered vacant by the death of Mr. Arthur Benthall. Mr. F. E. Baines, formerly Surveyor-General of Telegraphs, has now been appointed Inspector-General of Mails.

ELECTRIC LIGHT AT BOURNEMOUTH.—The Improvement Commissioners of this town are in treaty with the Electric Light and Power Generator Company for the introduction of their lamps in place of the present gas lights. Mr. Massey, manager of the Company, has been down to Bournemouth, to go over the ground, and was to send in an estimate.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the half month ended Feb. 28, 1882, were £1,600, against £800 in the corresponding period of last year, making the gross earnings for the whole month of February, 1882, £3,475, against £1,700 in the corresponding period of last year, or an increase of £1,775.

ELECTRIC LIGHT AT NORWICH.—Last week the Norwich Town Council unanimously accepted the tender of Messrs. Crompton and Co. for lighting a portion of the city with fifteen arc lights, from sunset to sunrise, for twelve months, at £400. These lights, we may remark, have been regularly in use during the past month, and have proved very successful.

LAYING THE TAY CABLE.—The "Morna," the Post Office cable ship, arrived in the Tay, off Broughty Ferry, near Dundee, on Saturday last about midnight, from Orkney, where she has been for the last fortnight or more repairing cables. She was to lay the new cable across the Tay, from the Harecraigs at West Ferry to the West Lights, near Tayport, this week.

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GERMAN UNION TELEGRAPH COMPANY.—The next ordinary meeting of this company is announced to be held at 4, Werderstrasse, Berlin, at 12 noon on the 31st instant. That of the "Company for the Laying and Maintenance of the German-Norwegian Cable" will be held at the same place and on the same date at 12:30, and that of the Hamburg-Heligoland Telegraph Company at the same place and on the same date at 1 p.m.

UNDERGROUND WIRES IN CLEVELAND (OHIO).—The National Underground Electric Company have requested the permission of the Cleveland Board of Improvements to lay underground cables on the Lamb patent system. This consists in placing underground cylindrical blocks of artificial stone with holes through them. These blocks are laid end to end like a gas main, a rubber pipe is placed in each hole, and in these the wires are placed.

ASSOCIATION OF MUNICIPAL CORPORATIONS.—At the annual meeting of this asociation, held at the Institution of Surveyors, on Tuesday, resolutions were passed to the effect that private Electric Lighting Bills were an unjustifiable interference with the rights of municipal corporations and other local authorities, and that the same be opposed; and that the Government be requested to give facilities to local authorities for the promotion of electric lighting.

ELECTRIC LIGHT IN CINCINNATI (AMERICA).—The Committee on Light, of the Cincinnati Board of Public Works, have reported in favour of permitting electric light companies to erect poles, wires, &c., for furnishing light, heat and power by electricity. The wires must not interfere with telegraph or telephone wires, and the privilege is granted only upon compliance with certain regulations regarding conductors, globes, &c.—*Sanitary Engineer* (New York).

EDISON'S LIGHTS IN AMERICA.—The *New York Post* says that a table compiled from the thirty or forty establishments throughout the country using the Edison lamps shows that when 15 lights were used their cost, as compared with gas, was as 11 to 15, when 60 were used the cost was half that of gas, and when 250 lights were employed the cost was 100 against 250, gas being considered as worth 2·00 dollars per thousand feet. We would remind our readers that gas is very much dearer in America than it is here.

THE FAURE BATTERY FOR TRAMCARS.—On the 22nd ult. a tramcar was run on the Leytonstone line of the North Metropolitan Tramways Company by means of the Faure accumulator and a dynamo machine connected by cog wheels and gearing to the wheels. The distance traversed was about 2½ miles. The dead weight of the car was 5¼ tons, the speed reached seven miles an hour, although the car was not of the most advantageous build for the purposes of the experiment. The experiment was successful, stopping and starting the car being effected with great promptitude. The experiment was carried out by Mr. Radcliffe Ward, engineer to the Faure Company.

ROYAL SOCIETY.—The following papers were to have been read before this society on Thursday, the 9th inst., viz.:—"Experiments to Determine the Value of the British Association Unit of Resistance in Absolute Measure," by Lord Rayleigh, F.R.S.; "On the Spectrum of Carbon," by Professors Liveing and Dewar, F.R.S.; and a "Preliminary Report to the Solar Physics Committee on a Comparison for Two Years between the Diurnal Ranges of Magnetic Declination as Recorded at Kew Observatory, and the Diurnal Ranges of Atmospheric Temperature as Recorded at the Observatories of Stonyhurst, Kew, and Falmouth," by Professor B. Stewart, F.R.S.

A NEW TELEPHONE.—The *Révue Industrielle* for the 1st inst. says that M. Bottscher has invented a new telephone. It is composed of a cylindrical copper box, 14 centimetres in diameter and 5 centimetres high, in which the different details are placed. A movable cover, with an opening in its centre, closes the box. To the right of this opening is a mouthpiece into which a person talks; the sounds strike a vibrating plate, screwed into the cover, the vibrations of which act on a magnet suspended from the sides of the box by three steel wires, the tension of which can be regulated at will. The action of the wires on the magnet is said to greatly increase the telephonic effects.

FOULING A TELEGRAPH CABLE.—The new Forth Cable appears to have had a narrow escape of being broken but a very short time after being laid. We read in the *Scotsman* of the 3rd instant:—"The foreign brig noticed yesterday as having been riding in Burnt Island roadstead in close proximity to the cable, lost an anchor, with 45 fathoms of chain, and had extreme difficulty in lifting her two other anchors. In bringing one of them to the surface, the cable was found attached thereto. It was at once dropped, without, it is believed, receiving material damage; at all events the communication had not been affected. The vessel proved to be the German brig 'Acona,' Captain Heidemann."

THE TELEPHONE AND THE GOVERNMENT.—*The Times* of the 7th inst. says:—"We are informed that, with the object of facilitating the further development of the telephonic exchange system, the Postmaster-General has conceded to the Lancashire and Cheshire Telephone Company the right to adapt their exchange systems for general public use at existing telegraph rates. This, it may be assumed, indicates that the Government, having vindicated their right to control the extension of the telephonic system, are prepared to grant reasonable terms to the existing companies. No doubt Mr. Fawcett intended to adopt this course from the first, but the difficulty of making the necessary arrangements for securing the rights of the Government as determined in the courts of law has caused delay."

THE ROYAL POLYTECHNIC.—The following prices were realised at the sale last week of the scientific and other apparatus lately the property of this institution:—An electrical railway, with iron rails, mounted on ten iron columns, and tram car with electro-motor, £11; a Wallace-Farmer's patent dynamo machine for producing electric light, £15; a large glass plate electrical machine, glass 7ft. diameter, on massive mahogany stand and square pedestal, £7; a large induction coil, by Apps, length 9ft. 10in., diameter 2ft., primary wire for ditto 3,770 yards long, secondary wire 150 miles long, covered with silk through its entire length, a manual mercurial brake, a commutator in box, a large automatic brake in box, and a large condenser, £22; the electric organ built by Messrs. Bryceson Brothers, £60.

THE ORKNEY AND SHETLAND CABLES.—On the 3rd inst. the Post Office cable ship, "Morna," in charge of Mr. Lumsden, successfully laid a new shore end to the Pentland Firth cable, at Rackwick Hoy, Orkney. This cable is said to weigh as much as 10 tons to the mile. During the operation of repairing the Shetland cable the "Morna" recovered a buoy lost in October, 1881, by the "Dacia," whilst engaged in laying a new cable between Shetland and Orkney. In the process of picking up the old cable it was found necessary to place a buoy to mark the broken end off Sumburgh Head (Shetland) in fifty fathoms of water. During the terrific gale of 14th October the buoy broke from its moorings, and

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was lost till the 25th February, when it was sighted by the "Morna" off the island of Anskerry (Orkney), the steamer being then engaged repairing the Shapinshay and Stronsay cable.

Royal Society of Edinburgh.—At the seventh ordinary meeting of this society, held on Monday, Professor Fleeming Jenkin, F.R.S., vice-president, in the chair, a paper was read by Dr. A. Macfarlane and Mr. D. Rintoul on "The Effect of Flame on the Electric Discharge." Dr. Macfarlane, who read the paper, stated that the flames experimented with were produced by means of an ordinary Bunsen burner, and were either clear or luminous. A charge of electricity, positive or negative, was produced on a disc placed at the side of the flame. The behaviour of the flame consequent on the charge of electricity was observed and recorded, as was also the force required to cause the electricity to discharge in the form of a spark. The experiments were said to throw some light on the discharge between a thundercloud and a chimney-stalk. We shall give an abstract of this paper in our next issue.

Defrauding by Telephone.—An action was brought in the City of London Court, on Tuesday, before Mr. Commissioner Kerr, by Mr. Hays, publisher, of Royal Exchange-buildings, E.C., against Mr. T. Cullen, accountant, of Vigo-street, Regent-street, W., to recover two guineas, the price of two theatre tickets. In evidence the plaintiff stated that on the 31st December last he received by telephone an order for two theatre tickets to be forwarded to the defendant; but that, when he sent in his account, the latter refused to pay it. The defence was that, as the defendant acts as accountant for several theatres, he thought the tickets were complimentary ones, and accepted them as such, never having ordered them. In the course of the hearing it was stated that there was a "strong suspicion that the use of the telephone is abused by designing and fraudulent people very frequently." The plaintiff stated that he had orders coming in to him every day by telephone.—Mr. Commissioner Kerr recommended him to state his case to the telephone company, and non-suited the plaintiff.

Foreign Telegrams.—At the recent meeting of the Associated Chambers of Commerce, held in London, a reply was received from the Postmaster-General in reference to a memorial forwarded to him by the Chambers, urging the necessity for a cheaper rate for telegrams to foreign countries, the pith of which was as follows:—"Barely two years ago a very considerable reduction was made in the charges for international telegrams, and the public were afforded the advantage of a word tariff, and the question of a further reduction in the rates cannot be reopened before the next international telegraph conference, which takes place in 1884. As showing the amount of the reduction made at the last conference, Mr. Fawcett would observe that in the case of the three countries mentioned in the memorial —namely, France, Belgium, and Germany—the reduction of tariff was, as shown below, and in the case of other countries a corresponding reduction was made. In the case of France, the former average cost per message was 4s. 4d., the present cost 2s. 11d., being a reduction of 33 per cent.; Belgium, former cost 3s. 4d., present cost 2s. 2d., a reduction of 35 per cent.; Germany, former cost 7s. 4d., present cost 3s., a reduction of 59 per cent."

Siemens' Electric Thermometers.—The Meteorological Society have placed one of Siemens' electrical thermometers on the summit of Boston Church in Lincolnshire, which is 270ft. high, and situate in a flat country near the sea. Ordinary thermometers have been placed on the belfry roof, 170ft. from the ground, and also in the churchyard. The electrical thermometer is connected by wires to a galvonometer and battery at the base of the tower. The instrument is read by depressing a key, which causes the needle of the galvanometer to deflect; a pointer or vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale until the needle remains stationary on the zero point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and, by referring to a table of equivalents, the actual temperature in degrees of Fahrenheit is readily ascertained. Simultaneous readings of the electrical thermometer at the summit of the tower and of the dry bulb thermometer in the churchyard will be made frequently during the day by the verger of the church. The society hope by this means to throw light on such questions as the vertical decrement of temperature, the rate of ascension of vapour, &c.

The Telephone in Zurich.—The Compagnie Téléphonique de Zurich have just instituted an innovation in the shape of public telephone offices. Anyone, subscribers or non-subscribers, can, on payment of a small fee, talk from these offices with any subscriber for a period of a quarter of an hour. The public offices number eleven. The company have also established, on a system analogous to that adopted by some American companies, a staff of commissionaires, who are always held in readiness at the head office to execute any commissions for subscribers at a small charge. The subscribers can also be put in direct communication with the central telegraph office, and dictate their messages direct instead of having to go themselves or send the messages; or, on the other hand, should a telegram arrive at the office for a subscriber he can have it read to him by telephone, a great saving of time and labour. During 1881 as many as 8,914 telegrams were thus transmitted by telephone. The company likewise call their subscribers at any hour of the night or morning that may be wished, and provide an automatic burglar alarm, which at once warns the central office if a safe or door be tampered with. The Zurich Telephone Company are evidently determined not to be behind their neighbours in rendering the telephone practically useful.

Electric Light in Nottingham.—On the evening of Friday week the works of Messrs. Copestake, Hughes, Crampton, and Co., Hounds Gate, Nottingham, were illuminated by the Brush electric light for the first time, the Hammond Electric Light and Power Supply Company, of 110, Cannon-street, London, having undertaken the contract. The engine which is used to drive the Brush machine was manufactured by Messrs. Reader and Co., of Nottingham, 16 horse-power being required to enable the machine to make 800 revolutions per minute, giving a current of 10 webers. The engine also drives the other machinery in the establishment. Mr. H. E. Harrison, director of the Company's Sheffield branch, has taken a prominent part in the making of the necessary arrangements, the whole being carried out under the personal supervision of Mr. A. Goy, electrician, also from Sheffield. The firm appear to be quite satisfied with the result of the experiment, and probably will be induced to extend the light to their other rooms should it continue to give satisfaction. This being the first warehouse in the town that has ventured to introduce the new light, considerable interest was taken in the matter, not only by the firm but also by the *employés*, who appeared to greatly appreciate the new light.

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NOTES ON ELECTRIC LIGHT ENGINEERING.*

BY C. H. W. BIGGS AND W. WORBY BEAUMONT.

Twenty-five years ago the man of science was able to obtain a very fair idea of the position of knowledge of a number of branches of science; but since then so great has been the progress and the development of each branch that it is as much as he can do to make himself thoroughly conversant with any one branch. Just so is it with the work of engineers. Gradually but surely an engineer has to confine himself and his labours to one distinct branch—it may be sanitary engineering, or bridge work, or railway work, and so on, whilst quite recently the extraordinary development of the applications of electricity seems to point to a great future for the engineer who devotes himself entirely to this branch of work. Although electrical engineering is still in its infancy, sufficient has been done to show the necessity for a better comprehension of the laws which determine the success of the work undertaken. Accidents at various places have, as is well known, occurred, but each of these accidents can be traced to a total ignorance, or a culpable negligence of the laws just referred to. There is no reason why an ordinary observer should be under the slightest danger from contact with connecting wires, or that any such danger as of fire to buildings should be possible. An electric light could be without danger, and many engineers would undertake without hesitation to put a lighted lamp into the middle of a powder barrel. We wish to emphasise the assertion that the accidents that have happened, or which may happen, are due entirely to insufficiently careful engineering.

Sufficient has also been done in the practical application of electricity to lighting purposes to indicate the directions in which engineers and electricians must work in order to arrive at the most economical and most complete systems of electric lighting plant. Much of the progress which has been made toward a large use of electricity for the purpose has been effected by engineers and practical machinists who have turned their attention to the subject. The electrician alone has moved slowly, and the engineer would move even more slowly, but the combined labours of the members of these two professions have brought about a sufficiently wide application of electricity for lighting purposes to enable us now to take stock of the information which has been obtained by the work thus carried out.

In considering the selection and arrangement of a set of electric light plant, the first question is the character or kind of light to be employed; secondly, the kind of electrical generator most suited for this light; thirdly, the kind of motor and means of transmission from motor to machine; and, fourthly, the apparatus and material for the distribution and regulation of the current between and at generator and lamp. If we speak, then, first of the kind of light, we have the choice of three kinds, that is to say, we have the choice of lamps of three kinds, viz.:—1, the arc lamps; 2, incandescent lamps; and, 3, semi-incandescent lamps.

Of these lamps, then, experience has only confirmed the reasons for selecting the arc lamp as the most suitable and the most economical for lighting large spaces, and, except in ornamental design, little now remains to be done in the improvement of these lamps other than in the perfection of the carbons employed. The incandescent lamp will probably remain permanently the best for general indoor illumination. It may, however, be found upon further experience that it is adapted also for street lighting purposes. Two things remain to be done in its improvement, viz., the perfection of the carbons and contacts, and the mechanical arrangements in processes of manufacture, so as to produce it at a minimum cost. The experience gained with these lamps is at present too small to speak with certainty as to their length of life. Many of the earlier ones lasted for comparatively a few hours, but improvement has been so rapid that the later ones have an average life of from 700 to 1,000 hours. Some of the makers guarantee this, others do so by guaranteeing renewals over and above a certain per centage, on condition, of course, that the lamps are worked properly. There is no reason why, as experience is gained in the manufacture of these lamps, and with the current regulated in accordance to the design of the lamp, the average life of a lamp should be limited to a thousand hours. It is quite probable that the average life may be extended to two thousand hours, or to even a longer period, and that the first cost of a lamp will be far less than the most sanguine expect now.

It is, perhaps, unnecessary to say more of the semi-incandescent lamp than that it does not seem to commend itself to public favour, although the light is steady and of moderate intensity. This may be on account of its cost. Referring now to the electric generator, which is usually a dynamo-electric machine, a selection has to be made in accordance with the selection which has been made from among the different lamps. It is, therefore, necessary to take into consideration the special requirements of the chosen lamp—for example, arc lamps may be chosen, such as Crompton's, as used at King's Cross, which require for three lights in series a machine having an E.M.F. of 250 volts, or we may have incandescent lamps such as the 20 candle-power lamp of Swan, which require a machine having an E.M.F. of 45 volts, or the Edison 16 candle-power lamps which require a machine having an E.M.F. of 110 volts, or 8-candle Edison which requires but half that E.M.F., and so on. It will thus be seen that the E.M.F. of the machine must be proportional to the resistance of the lamps. If this is not ensured, and if the machine has too high or too low an E.M.F., the carbons in the one case will be destroyed, and in the other will not be heated to incandescence. From an engineering point of view we may compare the E.M.F. to head or to pressure of water in an hydraulic system, and thus engineers not conversant with these terms will understand that E.M.F. is the electric condition necessary to overcome the resistance of the lamps, just as a given pressure in the hydraulic system is necessary to cause the plunger of a hydraulic press to move, and engineers will also understand that a quantity of water under that pressure, or similarly of electricity, under that condition is necessary to keep the plunger moving. Thus, a certain E.M.F. is wanted to overcome, so to speak, the resistance, and to put the lamp in a certain condition, as well as a certain quantity of electricity to keep up the condition.

The unit of E.M.F. practically employed is termed a *volt*, which is approximately the E.M.F. of a standard Daniell cell. This cell gives a certain deflection on, say a tangent galvanometer, and the E.M.F. of other batteries or electric generators is calculated in terms of such deflection.

Resistances are measured in terms of a unit called the ohm. A copy of the ohm can, like a pressure gauge or two-foot rule, be purchased at any electrical instrument maker's. As an illustration of the ohm, it may be mentioned that it is the resistance which an electrical current experiences in passing through a copper wire 10·29 ft. long and 10 mils. in diameter.

One of the most important points with which an electrical engineer should be acquainted is that of resistances. An electric current passes only when the conductor of that current forms a complete circuit. This circuit in electric light arrangements is divided into two parts, one being part of the machine itself, the other being the cables and lamps, &c., external to the machine.

The internal part of the circuit is the wire and commutator connection from brush to brush, and the resistance of this would remain constant after the machine is made if it were not that the metal varied its resistance with change of temperature, increasing with increase of temperature according to the following rate, ascertained by Dr. C. W. Siemens:—

$$r = \alpha T^{\frac{1}{2}} + \beta T \pm \gamma$$

T = absolute temp. reckoned from $-273°$ C

α, β, γ = constants. Thus for

Pt $r = 0{\cdot}039369\,T^{\frac{1}{2}} + 0{\cdot}00216407\,T - 0{\cdot}2413$

Cu $r = 0{\cdot}026577\,T^{\frac{1}{2}} + 0{\cdot}0031443\,T - 0{\cdot}22751$

Fe $r = 0{\cdot}072545\,T^{\frac{1}{2}} + 0{\cdot}0038133\,T - 1{\cdot}23971$

It is usual among outsiders to look upon the heating of the armature coils as affecting the insulation only, but it will be seen that the heating also affects the resistance of the circuit, and hence the steadiness of the light. The external part of the circuit is the one coming under the control of the engineer after the machine is made, and it is here that his knowledge of the laws affecting resistance can be applied in the successful arrangement of any system of electric lighting plant. We shall not enter into minute details, these will be found in text books. Generally, then, every substance resists more or less the passage of electric currents, some, such as metals resist the passage but slightly, and are called good conductors; others, such as glass, shellac, gutta percha, &c., offer an enormously great resistance, and hence are called non-conductors or insulators. The fundamental formula, which should be the basis upon which the calculations are made, is called Ohm's law, viz.:—

$$C = \frac{E}{R},$$

in which C = current
E = electromotive force
R = total resistance.

We have previously pointed out that the total resistance is divided into the external resistance and the internal resistance, and if we signify these by R and r respectively we may write the formula

$$C = \frac{E}{R + r}.$$

* Read at a meeting of the Society of Engineers on Monday, March 6th, 1882.

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Ordinarily the external circuit consists of the leading wires and the lamps. Now, the lamps can be arranged in three ways—

Firstly, one after the other (Fig. 1), when they are said to be in "series."

Secondly, in this way (Fig. 2), when the lamps are said to be parallel, or in divided or multiple arc.

A third way would be a combination in series and in multiple arc (Fig. 3).

Inasmuch as the resistance of the external circuit should bear a certain proportion to the internal circuit, in order to obtain the best effect there is a good deal of art required to arrange the lamps properly. Sir W. Thomson, at the last meeting of the British Association, in one of his papers concludes that the resistance in the external circuit should be about twenty times that in the internal circuit.

Fig. 1.

The calculations to obtain the value of the resistance R in these arrangements are fairly simple.

Firstly, in series the sum of the separate resistances = R; that is, we obtain R by adding together the several resistances of the lamps and the connecting wires.

Secondly, the resistance R is represented by a formula in the form of a fraction, whose numerator is the product of the n resistances; that is, the resistances of each branch, and whose denominator is the sum of the products of the combination of such resistances taken $n-1$ together. Thus the resistance of a circuit with two branches, with r (say 3 ohms) and r_1 (say 4 ohms), the resistance of each branch respectively, is—

$$R = \frac{r\,r_1}{r + r_1}, \text{ or with the figures } \frac{3 \times 4}{3+4} = \frac{12}{7} = 1\frac{5}{12}.$$

With three branches, the resistances being $r(3)\,r_1(4)\,r_{11}(5)$, the formula becomes—

$$\frac{r\,r_1\,r_{11}}{r\,r_1 + r\,r_{11} + r_1\,r_{11}} = \frac{3 \times 4 \times 5}{3 \times 4 + 3 \times 5 + 4 \times 5} = \frac{60}{12 + 15 + 20}$$
$$= \frac{60}{47} = 1\frac{13}{47}.$$

From this it will be seen that by arranging the lamps in multiple arc the resistance of the circuit is diminished. Thus, in the first of these examples the resistance in series is $3 + 4 = 7$ ohms, whereas in multiple arc the resistance is but $1\frac{13}{47}$ ohm. This is somewhat analogous to the resistance to the passage of water through, firstly, two pipes end on, and, secondly, to the two pipes placed side by side.

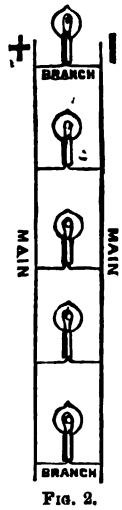

Fig. 2.

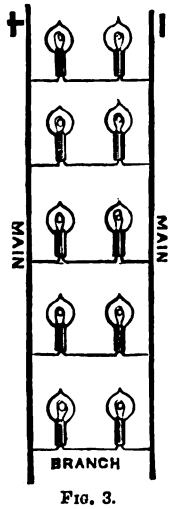

Fig. 3.

When the branch resistances are all equal, as is frequently the case with incandescent lamps, the formula is very simple, and becomes

$$\frac{R_1^n}{R_1^{n-1} \times n} = \frac{R_1}{n}$$

where R_1 = the resistance of one branch,
n = the number of branches.

Thus, if in the previous example, of $r = r_1 = r_{11} = 5$ ohms we get

$$\frac{5^3}{5^2 \times 3} = \frac{5}{3} = 1\frac{2}{3}.$$

Thirdly, the resistance is obtained by a combination of the previous methods.

But it must be remembered that each lamp requires a certain current C. For example, some arc lights require from 20 to 30 amperes, while incandescent lamps require only from 1 to 2 amperes.

The lamps have, therefore, to be arranged not only with regard to resistances, but with regard to the quantities of current required.

The current passing through any branch circuit being inversely proportional to the resistances, we obtain the following formula for the current in any branch of multiple conductor.

Let C_1 = current in branch.
C = total current.
R_1 = resistance of branch.
R = joint resistance of circuit.

Then

$$C_1 : C :: R : R_1,$$

that is

$$\frac{C_1}{C} = \frac{R}{R_1},$$

$$\therefore C_1 = C\frac{R}{R_1}.$$

As an example of these calculations, we may take the following hypothetical case:—

Suppose we have a machine, the E.M.F. of which is 200 volts, and internal resistance = 1 ohm; suppose E.M.F. required by lamps = 40 volts. The current required through lamp, 2 amperes, and the resistance of the lamp 20 hot ohms.

Fig. 4.

If we were to arrange these lamps in series, neglecting the wire resistance, we should be able to put with this machine 5 lamps (Fig. 4). thus—

$$C = \frac{E}{R}$$

$$C = \frac{200}{5 \times 20} = \frac{200}{100} = 2 \text{ amperes};$$

but this makes the external circuit to have a resistance of 100 ohms; whereas, for the most effective working, the external

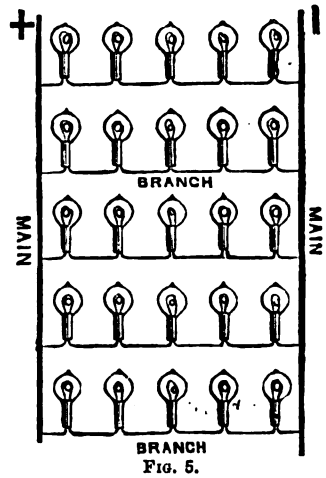

Fig. 5.

resistance should be but 20 ohms. Without this, however, there are other reasons why the method could not be used, and it will be seen that by arranging twenty-five lamps in a five-branch circuit (Fig. 5), each circuit having five lamps in series, the resistances and circuit would be as follows:—

$$R_1 = 5 \times 20 = 100 \text{ ohms.}$$

$$R = \frac{100^5}{100^4 \times 5} = \frac{100}{5} = 20 \text{ ohms.}$$

$$C = \frac{E}{R} = \frac{200}{20} = 10 \text{ amperes.}$$

$$C_1 = C\,\frac{R}{R_1} = 10 \cdot \frac{20}{100} = 2 \text{ amperes,}$$

this circuit having the proportionate resistances suggested by Sir W. Thomson, and the current as required through each lamp.

We have now glanced at a few of the calculations with the methods of which it is necessary the electric light engineer should be perfectly familiar. It is unnecessary for us to describe the practical methods employed for finding resistances, electromotive force, &c. These are pretty generally known.

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At present copper wire is used for carrying the electric current, and, in order to guard against fire, should the current by some means sent into the wire be too great for its capacity, and hence heat it considerably, it has become customary to insert short pieces of fusible metal, such metal easily conducting the ordinary current, but fusing should the current be much stronger, and thus, by breaking the circuit, stopping the current, and so the danger. It may also be necessary, through the extensive use of copper, and consequent rise in price, to attempt the use of some other metal for conducting purposes. The engineer, then, should be familiar with the sectional area and other properties of the wire he uses, in order to exchange his conductors, or parts of them.

The dimensions of equivalent conductors have been simply described by Matthiesen and Hockin. The resistance of a given material varies directly as its length and inversely as the area of its section, or as the square of the radius.

Let L = length,
r = radius of section of wire,
S = specific gravity,
W = weight,

then resistance varies, as $\frac{L}{r^2} = \frac{L^2 S \pi}{r^2 S \pi L} = \frac{L^2 S \pi}{W}$.

So that to determine dimensions of the wire L must be known, and then either diameter or weight of wire and specific gravity.

To find diameter of wire (D),

let S = specific gravity,
W = weight,
L = length,
r = radius,
D = diameter,
π = 3·1416; log. π = ·4971499;

then $W = \pi r^2 L S$

$$r^2 = \frac{W}{\pi S L}$$

$$r = \sqrt{\frac{W}{\pi S L}}$$

$$2r \text{ or } D = 2\sqrt{\frac{W}{\pi S L}}.$$

Thus the diameter of a piece of hard drawn silver wire, with L = 2138, W = 7·0189, S = 10.455, is ·632, the resistance of a material depending on length, section, and conductivity.

Then with two conductors C C_1, wire length L L_1, conductivity K K_1, and section S S_1, we should get the same resistance, and the one might be substituted for the other, when

$$\frac{L}{K S} = \frac{L_1}{K_1 S_1}$$

Suppose, for example, we wanted to replace a copper wire with iron wire of the same length, we should, of course, require the iron wire of greater sectional area, because its conductivity is less than that of copper. The ratio of the conducting of wire to copper is as ·138 : 1.

From the formula L being constant,

$$K S = K_1 S_1,$$

or as sections are, as the square of diameter,

$$K D^2 = K_1 D_1^2.$$

Now, if the diameter of the copper wire is, say, one inch,

$$1 \times 1^2 = \cdot 138 \times D^2$$

$$D^2 = \frac{1^2}{\cdot 138} = \frac{1}{\cdot 138} = 7\cdot 2 \text{ nearly},$$

$$D = \sqrt{7\cdot 2} = 2\cdot 7 \text{ nearly},$$

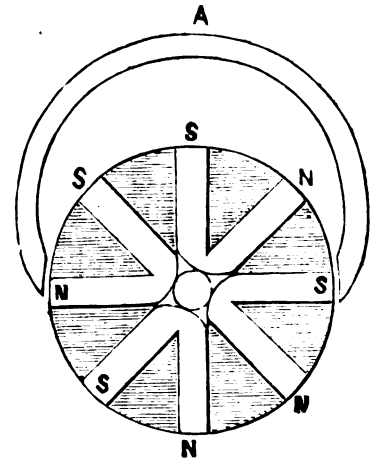
which shows that the diameter of the iron wire required to conduct the same current as the copper wire must be 2·7 times, greater. Now, 100 inches of copper conductor 1in. diameter would weigh about 25lb., and cost, at say £90 per ton, about 19s., while the iron conductor 2·7 inches in diameter, and 100 inches long would weigh 160lb., and cost, at £7 per ton, about 10s. Thus the relative cost of iron to copper is about 1 to 2. It must, however, be noticed the cost of the metal is not the only cost inasmuch as insulating material to cover the iron conductors would be about as 3 to 8, except in the case of large conductors placed in troughs filled up with cheap insulating material.

Further, the extra size and stiffness of the iron wire would undoubtedly increase the mechanical difficulties of installation. Notwithstanding this, however, there is a considerable margin in favour of iron for a great many purposes.

Before referring to dynamo machines it may be interesting to call attention to the first description of a machine in which electro-magnets were required. Our attention was directed to this letter by Dr. Muirhead. The letter originally appeared in the *Mechanic's Magazine* for 1834, vol. xix.:—

"Dynamic Application of the Newly-Discovered "Electro-Magnetic Influence.

"Sir: The prefixed figure represents a dynamic application of the newly-discovered electro-magnetic influence. A is an arc of iron, measuring about two-thirds of a circle, and supposed to be armed with the helix of wire, and connected with a galvanic battery in the usual way. N S, S N, &c., is a solid circle, showing a section of its axis at the centre, and having fixed on its surface the magnets N S, S N, &c. These magnets are built of steel bars, bent so that their straight parts shall incline to each other at an angle of 45deg. There are many such bars in each, and the whole compound is firmly fixed on the solid circle, with the straight parts in the direction of its radii. The wires which form the connection between the poles of the iron arc and those of the battery are to be so arranged that the connection may be interrupted or reversed at stated times. Finally, the solid circle is to be so adjusted with respect to the arc that it will revolve all but in contact with them and that a line joining them will pass through its centre. The action will take place thus:—Suppose the battery in connection with the arc, and that any two of the magnetic poles of the circle are within one-third of their common interval, or 15deg. of the poles of the arc; since the peculiar arrangement of the magnets ensures there being always poles at opposite sides of the circle, the sum of the mutual attractions of the arc and magnets will be exerted in giving rotary motion to the circle. The moving power will continually increase until the centres of the magnetic poles fall into the line of junction of the arc poles; here the machine must itself interrupt the communication between the arc and the battery. The circle being supposed so massive as to serve for a flywheel, will continue to revolve until the next pair of magnetic poles ap-



proach within 15deg. of the arc poles; here the machine must itself renew the connection, and, if necessary, reverse it also. The expense of power involved in this suspension and change of the current of electricity will be trifling indeed, as the necessary effect will be produced by the shifting of a few wires, which do not present among themselves any attraction to be overcome. Such is the singular nature of this power that it is absolutely latent, except just at the point where you please it should develop its mighty energies. The facility, also, and instantaneous quickness with which it reverses the direction, without impairing the energy of its force, are no less wonderful, paralleled only by the similar qualities of steam. The quantity of power that has been developed by actual experiment with the electro-magnetic apparatus is so considerable as to leave no doubt of its efficiency as a mechanical agent. There are, however, to be taken into account its strong disposition to concentrate itself, and its rapid decrease in proportion to the distance from the point of development. Notwithstanding these disadvantages, I should anticipate a satisfactory average of constant working power produced. It may be objected that a serious check will be sustained by the circle, at the moment of any suspension of the galvanic influence, in consequence of the tendency the magnetic poles would then exert to maintain their places opposite to the arc poles, which, though now inert, are still iron. To this I should answer, that that tendency will bear but a small proportion to the impelling force the moment before exerted, and that this impelling force being continued by the mass of the circle will find but little difficulty in overcoming the retarding influence, which, moreover, being overcome in the first instance, lessens so rapidly (according to the law of magnetic influence) as to become zero very soon. If, however, the loss of power so sustained should prove equivalent, or nearly so, to the gain

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made by having the radii magnetic, the difficulty may be at once got rid of by making the radii of unmagnetic iron. I am sanguine, Mr Editor, in hoping that some of your contributors will put this matter to the test of an experiment. $\phi. \mu.$"

In the construction of dynamos there are few points to which attention may be directed. It is desirable that the armature coils should have the highest practicable velocity in passing through the magnetic field. The construction of armatures which will withstand the strain of this high velocity is a mechanical question which must occupy the attention of electrical engineers. It would be an advantage, for instance, to be able to cut through the magnetic field at a velocity equal, to say, 10,000 feet per minute, but the centrifugal tendency of such velocities would be so great that it would be necessary to employ a system of construction not yet devised. An armature, so far as is at present known, must consist of a combination of conductors and non-conductors. It must be built up of many parts, some of which have little structural strength, and steel can be but little used in it, because of its becoming permanently magnetic. The difficulty arises from the necessity of building up the armature of soft iron, which is magnetisable, and of another metal which is not magnetisable, with interposed insulating materials, and, at the same time, making it and its connections with the commutator simple, good and inexpensive. Phosphor and manganese bronze have great strength, and provide the means of making enormous armatures, but both these materials are costly. The difficulty is, probably, not very great, and needs only to be known by engineers to be overcome. There are other directions in which there is room for improvement in the construction of dynamos, as, for instance, an arrangement by which the whole magnetic field, instead of part of the field, may be cut by the armature.

In the construction of combined steam engines and dynamo machines the simplifications already referred to may be carried a little further, for there does not seem to be any reason why the bed-plate and crank-shaft brackets should not be made to form the field magnets, while the fly wheel may constitute the armature. There are some difficulties to be overcome, but they do not seem to be insurmountable, and one advantage would be that the combined machine so made need not weigh more than two-thirds that of the present form of combined engine and machine on one bed.

Engineers have also a good deal of room for invention in providing means for imparting the necessary high velocity to the armature in the most economical way, whether this is to be done by large armatures or very high velocity of rotation of small armatures.

With respect to the motive power for generating electric currents, the steam engine is at present mostly employed, and gives the best results. A good deal has recently been said concerning the future of the steam engine, and Sir F. Bramwell has been followed in his prophesy that the steam engine is on its last legs. This may perhaps be a safe prophesy, as neither Sir F. Bramwell nor his followers have assigned any period as that of the life of these last legs. They do not tell us whether they will last as long as they yet have, or whether it would be well to collect the best steam engines for museum purposes at once. Gas engines have not yet been made of sufficient power to meet the requirements of large installations, and they are not sufficiently uniform in velocity of rotation to give the best results. Neither do they always run without making an uncalled for stop. There are many situations whereat water-power may be made available, as it has been by Sir W. Armstrong, and as it may be at Bristol and elsewhere by the rise and fall of the tide. In the greater number of cases, however, and for some time to come, steam will probably be the chief motive power. Electric light engineers are as much the manufacturers of light from coal as are the gas engineers, and assuming that steam engines are to be the chief medium in this manufacture, it would seem that its improvement more than ever forces itself on engineers. By the introduction of the compound system, a great reduction in the consumption of coal has been made, and particularly so by the small engines now largely used for electric lighting purposes.

A lecture was given in Paris, and subsequently published and circulated in this country, by Professor Ayrton, in which a very unfair comparison was made between the cost of power from steam engines and from gas engines. The comparison was made on the assumption that steam engines consumed 6lb. of coal per horse-power per hour, and gas engines used but 18 cubic feet of gas per hour. Every engineer knows that steam engines are common enough that consume but 2lb. of coal per horse-power per hour, and a report by Mr. Michael Longridge, on the trial of a compound engine, in a mill at Farnworth, was published in the *Engineer*, which showed that the consumption by an engine of moderate size—namely, about 300 indicated horse-power—need not be more than 1·85lb. per indicated horse-power. With coal at 10s. per ton, this represents a cost of 0·09 pence per indicated horse-power per hour, or under one-tenth of a penny. At 15s. per ton the cost would be 0·138 pence per indicated horse-power per hour. Now, the largest gas engines yet made are said to have used but 17 cubic feet of gas per indicated horse-power per hour, and this, at 3s. per 1,000, makes the cost of power by the best gas engines 0·612 pence per indicated horse-power, or over six times as much as for power from good steam engines. The gas engine has, therefore, a good deal to do yet, and the steam engine's legs may not be so very shaky at present. When gas is used made by Mr. Emerson Dowson's process, the cost is said to be considerably less; but we are not yet warranted in comparing gas engine-power from this gas with steam engines.

It has not yet, however, become a matter of cost only in comparing gas engine-power with steam engine-power for working dynamo-electric machines; for, so long as the piston of gas engines receive but one impulse in every four revolutions the regularity in their running is incomparably inferior to that of the steam engine. It is highly necessary to maintain a constant electromotive force in the electric mains, and this is at present best done by varying the speed of the engine, which can be well done with steam engines with good governors and valve gear, such as the Corliss, controlled by an electric regulator. It cannot be so done by gas engines as yet constructed. In the Mansion House plant Mr. Crompton has to a considerable extent overcome the irregularity in the electromotive force by putting a fly-wheel on the dynamo shafts; but this is an undesirable addition which is not necessary with the steam engine. The electromotive force may, of course, be regulated by an artificial resistance, but this is wasteful. Preparatory to making any remarks on the relative cost of electric and gas lighting, it should be stated that here cost is not the only item to be considered. The electric light, to put it briefly, is better than gaslight, and offers several advantages not offered by gas. These we need not enter into, as they are generally conceded by all who have considered the subject, or visited the Paris or Crystal Palace Exhibitions, or the Savoy Theatre.

Secondary Batteries.

One great defect of the electric light when obtained on a small scale is the disproportionate cost of one light to that of a hundred or a thousand lights. When the shades of evening begin to fall it is possible to light one gas burner, but for one electric lamp the steam engine and dynamo must be put in motion. We say must, for although the public has heard a good deal about secondary batteries it has seen little of them. Yet methods of storing up electricity—to be used as conveniently and in as small quantities as is gas—are as certain to be developed and perfected as that we are now discussing the question. The problem to be solved is fairly well known, and there are rumours of more than one experimenter having obtained a satisfactory solution. At present, however, only two secondary batteries can be purchased—those of M. Planté and M. Faure. The ultimate principle of both these batteries is the same. M. Planté commenced his experiments in 1859. Briefly, he takes pairs of lead plates, but for the purpose of explanation we will speak of a pair of plates. These plates are placed in dilute acidulated water, and connected to the poles of a battery. The action of the battery, as is well known, is to decompose the acidulated water, and hydrogen is given off at one of the lead plates, oxygen being given off at the other. This nascent oxygen combines with the lead to form a peroxide of lead. If now the current from the primary battery is stopped, and the heated lead plates joined through a galvanometer by wires, they will be found to give a current for a longer or shorter time, according to the quantity of peroxide of lead. The peroxide is degraded, and it is this degradation or deoxidation that gives the secondary battery current. The upshot of the primary current is a particular chemical combination; the reversal of this, or the decombination of this chemical, gives the secondary current.

In order to obtain a good coating of peroxide the Planté cell has to be charged and discharged a large number of times, and preferably with a constant change of poles. In this manner the lead plates are eaten as it were into a porous condition, and when in this condition they are said to be "formed." After being thoroughly formed they are always charged in the same direction.

Now in January, 1881, M. Faure patented his form of battery. Instead of obtaining a good coating of peroxide of lead by electrolysis he uses his lead plates as a backing and a coating of red lead (which consists mostly of peroxide of lead) mixed with dilute sulphuric acid on the plates.

The object of both M. Planté and M. Faure is, as stated in M. Faure's patent, "to obtain plates of lead or other suitable material covered with pulverulent lead."

We have for many months past given a careful attention to

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the theory and the construction of secondary batteries, and were often surprised to find how exhaustively the subject had been discussed by those who experimented years ago. It may be interesting to notice here how the recent great practical applications of electricity have been founded upon phenomena which were formerly the bugbears of electricians. Such, for example, as the microphone dependent on its success upon bad contacts—things hateful to those telegraphists who walked in the old-fashioned paths. The secondary battery is the outcome of "polarisation," the very thing inventors have tried to get rid of, and so on. We feel quite jubilant that these bye products, these nasty hindrances to the good old electricians, should turn out such useful creations. Time was when a gas works was noted for its waste products, but science and civilisation—that is, Paris fashions—have turned the waste products into good honest coin of the realm. This is a digression, and we will return to history.

It does not seem to be generally known that tolerably complete descriptions of all that has been done in secondary batteries were published many years ago. The technical literature on the subject seems to be but little known, though important information was published in an English periodical on March 20th, 1863. The *ipsissima verba* of the article is as follows:—

"The great power of the secondary combinations we have referred to is due to the presence of the peroxide of lead in contact with the negative element in these combinations. This substance, as was pointed out by M. De la Rive, surpasses even nitric acid in its affinity for hydrogen, and for this reason a couple constructed with a negative element of platinum, *surrounded by a mixture of dilute sulphuric acid and the peroxide of lead*, and with a positive element of amalgamated zinc, in dilute sulphuric acid, is more powerful even than the couple of Grove. And when lead, instead of platinum, is used for the negative element, the power of the couple is but little diminished."

Attention must be directed to the fact that the negative element was surrounded by a mixture of peroxide of lead, with dilute sulphuric acid, and this mixture was evidently put on or around by hand, for the writer goes on to speak of the great cost of the peroxide as obtained by chemical methods, and to show how his readers might obtain it electrolytically, as indeed did M. Planté. Although it is not specially mentioned that both poles might be of lead, it can be inferred that this was well known from further remarks of the writer and of other correspondents to *The Electrician*, in which paper the article referred to appeared.

These notes have but briefly referred to many matters which are exceedingly interesting to the engineer; but we hope they may induce others who have had larger practical experience to come forward and give from the stores of that experience hints which may be useful to those who are looking for a field in which their energies may with advantage be thrown.

[N.B.—We understand that a brief description of the apparatus shown, viz., machines, lamps, &c., will be given at the commencement of the adjourned discussion on this paper on Monday, 20th March, 1882.—ED. *E.*]

THE ELECTRICAL RESISTANCE OF CARBON UNDER PRESSURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the abstract of the proceedings of the Physical Society, given in *The Electrician*, No. 16, March 4, I learn that Professor S. Thompson has been making some experiments which tend to show that the observed diminution of the resistance of carbon under pressure in such instruments as the carbon relay, rheostat, and microphone transmitter is really due to the contact between the electrodes and the carbon. No doubt the greater portion of the observed diminution of resistance is due to this cause, and I have already pointed out in my paper on "The Influence of Stress and Strain on the Action of Physical Forces" (Part II., Electrical Conductivity), an abstract of which (*Nature*, No. 643, Feb. 23) was read before the Royal Society on Jan. 26, that the effect of a given amount of longitudinal traction or compression per unit area on the electrical resistance of some carbon rods was not greater than is the case with the metals tin and lead, for, whereas a stress of 1 gramme per sq. cm. produced a variation of conductivity of from 7684×10^{-12} to 11420×10^{-12} per unit in the case of five carbon rods, the corresponding numbers were with tin and lead 10540×10^{-12} and 17310×10^{-12} respectively. The carbon rods were of the sort used for the purposes of electric lighting, and their elasticity varied in almost the same proportion as their susceptibility to change of resistance from stress, so that the alteration of resistance divided by the stress producing it ranged in the five specimens between the limits 2·144 and 2·835. The corresponding numbers in the case of most pure metals (aluminium is an exception) are greater than these, and in the case of nickel, with which metal, curiously enough, *decrease* of resistance attends moderate longitudinal traction, the alteration of conductivity is *much* greater.

It will be observed from the numbers given above that the diminution of resistance which is caused in carbon by pressure is very slight, so much so, indeed, that if we could compress a carbon rod to *half* its original length, the resistance would not be diminished to one-third of the original resistance, and that, therefore, the amount of compression which can be really produced without danger of breakage causes such a slight decrease of resistance as requires special precautions and a good galvanometer, if this decrease is to be measured with any accuracy.—Yours, &c.,

King's College, March 7. HERBERT TOMLINSON.

CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the meeting of the Direct United States Cable Company, reported in your issue of the 25th ult., a statement was made by the chairman to the effect that in the attempt to repair one of the cables of the American Atlantic Cable Company, which was broken in course of laying, the other cable had been cut through.

There is not the slightest foundation for this statement. The cable was broken near the Flemish Cap, by accidental causes, and was not cut through by a grapnel, or other mechanical means, as reported.

The cable was repaired on the 1st instant, at a depth of 1,950 fathoms, and is now again in perfect condition.

I am requested by my Board to ask you to kindly insert this correction in your next issue.—Yours, &c.,

ALFRED SABINE, Secretary.

LECTURES AT THE CRYSTAL PALACE.

THIRD LECTURE.

Professor Sylvanus Thompson's third lecture on "Electric Arc Lights" was delivered on Wednesday night at the Crystal Palace, in the large concert room. The electric arc was discovered about the year 1804 by Sir Humphrey Davy when experimenting upon the different kinds of sparks produced between wires of various materials attached to the terminals of a large voltaic battery. Sir Humphrey found that when pieces of charcoal were tied to the battery wires, were then brought for a moment into contact, and then withdrawn apart to a short distance, a kind of flame played across from one charcoal point to the other, whilst the charcoal points themselves glowed with a most intolerable brilliancy. The difficulty of applying and using this voltaic arc or flame arose from its excessive sensitiveness, which made it flicker when there was the smallest irregularity either in the flow of the electric current that fed it or in the quality of the carbon. Pencils of hard artificially-prepared coke carbon were now universally used instead of wood charcoal. To control the light the carbon pencils were held by an instrument called a regulator or electric lamp. The regulator had to perform the office of feeding the carbon pencils into the arc as fast as they burned away, the rate of feeding being controlled electrically by the strength of the current that passed through the lamp. This operation of feeding was in some cases performed by a clockwork train operated by springs, or by the weight of the descending rod of carbon. Another requirement which the regulator must satisfy was that in case of extinction of the arc it should relight it by bringing the carbon points together and then separating them to the necessary distance. Diagrams of the construction of the principal forms of lamp were shown, and several lamps of the various leading systems were exhibited in action. Illustrations were also given of the method of calculating the actual amount of energy used up in the lamp, as well as of its light as compared with that of a standard candle. The lecturer stated that the gas which would yield a horse-power of energy would burn with a steady light of 42 candle-power per hour, while the same amount of gas burned in a gas engine and used to drive a dynamo-electric generator might maintain an electric arc light equal to that of 2,000 candles. Referring, in conclusion, to the prejudice against the glare of electric arc lights, the lecturer quoted from a report drawn up in France when gas was first introduced, in which it was stated by an eminent man of science that the light of gas was of a disagreeable yellow colour, entirely different from the red and warm gleam of oil lamps, and of dazzling brightness. The same writer went on to say that its distribution would be impossible and irregular, and it would be much dearer than oil lamps were. They had now an instance of the way in which history repeated itself; and when they went out of their way to babble about the disagreeable colour or the irregularities or the expense of electric lights, they must remember that half a century hence posterity would smile at these objections as being just as ridiculous as the objections raised in 1819 to the light of gas.

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THE STORAGE OF POWER*

The subject of this lecture has been called by the world at large, even by well-informed *Punch*, "The Storage of Force." Why, then, have I ventured, in my title, to differ from so popular an authority? For this simple reason—that you cannot store force any more than you can store time. There is as much difference between force and power as there is between a mile and the speed of a train or between a ship and a voyage. Power involves two distinct ideas combined, whereas force only involves one. When a weight rests on the ground, the weight pushes the ground down with a certain force, and the ground pushes the weight up with the same force. If, then, there were such a thing as a storage of force, the more resting of a weight on the ground would be such a storage, since the force exerted between the weight and the ground never grows less. But, I need hardly say, it would be beyond the power of the cleverest engineer to work a machine, or drive a train, by using a weight resting on the ground; the very expression, "dead weight," shows how useless it is for the practical purposes of producing motion. A weight resting on the safety-valve of a steam engine may be a very good means of adjusting the pressure at which the valve shall open and liberate the excess steam, but this weight will never work the engine.

What, then, is the other component idea, in addition to force, that must be present to obtain power or work? The answer is—motion. Work is force exerted through space; the pressure that this weight resting in my hands produces is a force and not a power, but the operation of raising a pound weight through any height is doing work, and when the weight has been thus raised it has a store of power or energy in it, which is the greater the larger the weight and the higher the distance through which it has been raised. The raised weight is in a different state from that in which it was when resting on the ground; it can now fall, and in falling do useful work. If a weight of P lbs. be raised through F feet, P × F foot lbs. of work will be done, and there will be a store of P × F foot lbs. of work in the raised weight. A raised weight store of energy is employed to drive some of our clocks, to help us raise our windows, our chandeliers, and for many other purposes.

The continuous evaporation of the water from the seas and rivers by the heat of the sun, and its subsequent deposit in the form of rain on the hill tops, supplies us with another very large raised weight store of energy, and which is practically utilised when water falling down the hillside works our waterwheels and turbines.

The vast fields of coal underground form another enormous store of power—not force, bear in mind—the initial work, in this case corresponding with the winding up of the clock by hand or the raising of the rain-clouds by evaporation, being performed by the leaves of plants. Under the influence of sunshine these split up the carbonic acid gas in the air, liberating the oxygen and absorbing the carbon, thus making wood, which eventually, after long ages, becomes coal. But there are other substances besides coal and oxygen which are found separated from one another, and which desire to recombine, constituting, therefore, stores of energy; blocks of pure copper, for example, are found near Lake Superior. But copper is too expensive a substance to be employed as fuel; it is also not a good heat-giver; that is, the burning of a pound of copper is not equivalent to much work. Zinc is, as a rule, not found pure in nature; when, however, it has been separated from its oxygen, the tendency of these two substances to recombine forms a valuable store of power—the one, indeed, almost entirely employed by telegraph companies in their batteries, in which the energy is developed for working their various electrical apparatus.

In all the preceding cases a store of power arises from the separation of two bodies which desire to come together. In the same way, you may remember, I told you here last year, in my lecture on "The Production of Electricity," that the power which an electrified body has to do work arises from its being separated from other bodies possessing a charge of the opposite kind of electricity. We may also have a store of power arising from two bodies being too close together, and which desire to move apart; as, for example, in a coiled spring, in compressed gas, in two similar magnetic poles, or in two similarly electrified bodies near together.

I have here several examples of stores of power, and I will now utilise them one after the other. First, I have a raised weight, and on liberating it this grindstone commences to turn. There is a cistern of water on the top of this building, and, the water falling down, works this turbine which is driving this rotary fan, producing a system of ventilation, which is practically employed at the Institution of Civil Engineers and other buildings. The coiled spring in the clock over our heads is driving the train of wheels constituting the clockwork. This gas engine, burning ordinary coal gas, is driving the fret saw.

This battery, in which zinc is burnt, is driving the lathe. This small engine, you see, is worked by air compressed in this iron reservoir, and is a plan which has been employed with success for driving tramcars. And, finally, the store of electric energy in these accumulators is driving this sewing machine. [Experiments detailed above shown.]

Now, the water which is falling from the top of the building, and which is working this turbine, was really stored in the cistern for drinking and working purposes, and, although serving us as a store of power, it was not pumped up for this purpose. Indeed, the price charged for water by the water companies would prohibit its use for the production of power. For, with water at a pressure of 100 feet, and at as low a price as 6d. per 1,000 gallons, it would cost 1s. 4d. per horse-power per hour.

In addition to the natural stores of water power on our hill-tops, there are also artificial stores of water power, or Armstrong's water accumulators, as they are called, although invented long before Sir William Armstrong's time, and which are employed in many large steel works, docks, &c. You know that by pumping water into a cylinder containing the ram of a hydraulic press, large weights can be raised, but as it would be inconvenient always to have to start the steam engine to work the pump just when it was required to move a piece of steel in the works, or to open the dock gates, the water is periodically pumped into a cylinder with a heavily-weighted piston, and which is, therefore, raised when the water is pumped in. If then, at any moment, at any part of the works power is required, a tap is opened, and this large weight falling at the reservoir cylinder, drives out the water and performs the desired piece of work. The large diagram shows the arrangement, the heavy weights resting on the piston being formed of a mass of brickwork about 10ft. in diameter, and weighing some 26 tons. When raised, then, 6 feet, it has a store of energy equal to one horse-power exerted for about ten minutes. Although it is a form of water accumulator of power it is clear that the general principle is simply that of a raised weight, and is of the same nature as the wound-up weight which drives a clock.

Now I want to consider how far it would be possible to drive a tramcar by one or other of these various sources of power. An ordinary tramcar for 46 passengers weighs 2½ tons, and when full of people about 4½ tons. To pull such a car at the rate of 6 miles an hour along an ordinary line requires about 1½ horse power. To produce such an amount of power for one hour requires an expenditure of over two million eight hundred thousand foot lbs. of work, or if produced by a weight falling say through 10 feet, would require the weight to be over 100 tons. It is quite clear therefore that Armstrong's water accumulators (that is to say simply raised weights), which are so successfully employed in many factories, would be absolutely useless for the purpose of propelling a tramcar, since the raised weight to be carried by a car, the gradual weight of which should move the car, would be infinitely greater than the weight of the car itself. Springs coiled up at the commencement of the journey, and allowed to uncoil during the passage of the car have also shown themselves to be hopelessly cumbersome and unpractical. Steam engines are occasionally employed on tram lines, and from the point of economy are much superior to horses; but there is the great disadvantage of the smoke, noise, and the terror of the horses of other vehicles. A detached tramway engine weighs also as much as a full car, consequently nearly half the total horse power employed is used in propelling the engine and boiler. The tram engines are also not economical, since small engines lose heat from their boilers very rapidly, and their construction is such that small weight is of more importance than economy in fuel. There is always considerable waste of oil, tallow, or stores on locomotives, combined with much cleaning, which causes an expense not felt in the case of stationary engines. Consequently the fact that steam engines for tramways are more economical than the employment of horses only shows how very uneconomical this latter method, which may be regarded as a remnant of the old coaching days, really is.

Gas engines worked with ordinary coal gas, stored under pressure in cylinders, might be employed on the tramcars, but although there would be a saving in weight in the absence of the boiler and coal, and although cheap heat giving gas like that made by the Dowson process could be substituted for the more expensive illuminating gas, there would be the compensating disadvantage that per horse-power the weight of a gas engine is so much greater than that of a steam engine.

Compressed air engines have been employed with considerable success by Colonel Beaumont for driving tramcars, and he has succeeded in storing in one cubic foot of air, at 1,000lb. pressure per square inch enough power to pull three tons about half a mile along an ordinary tramway. But, successful as this system is from the point of economy, there is the same objection that there is to the steam tram, viz., the comparative great weight of the locomotive. The detached compressed air engine weighs about 7 tons, while the car full of passengers is hardly 5 tons, so that seven-twelfths of the total horse-power expended is employed in pulling the compressed air engine alone. I understand it is proposed to build combined cars and compressed air engines, a change that will probably lead to a great improvement.

In order to obtain mechanical motion we require a store of power and some machine for converting the energy stored into mechanical work. Now, experiment shows that the weight of an electric motor is but a small fraction of the weight of a small steam engine and boiler per horse-power development. For example, I take this little motor, which is quite light, and which, only being attached to two flexible wires, is quite easy to move about, and you observe with what facility I can, by means of it, drill holes in this thick wood. I can drill holes upwards, downwards, or in any position, and with great speed. [Experiment shown.] Again, take the case of this electric hoist lent me by Dr. Hopkinson, its weight is comparatively small, and yet by means of it these heavy weights are conveniently and rapidly raised, and as the motive power is conveyed through these comparatively thin wires the hoist can, without difficulty, be shifted to another part of the works *while a weight is being raised*. This hoist is now being worked with eight Faure accumulators. [Experiment shown.] Contrast with this ordinary travelling cranes worked by a steam engine, in which the engine and boiler has to be itself moved as well as the crane, since the engine, boiler, and crane are really all in one. Electric motors indeed can be easily made to give out work at the rate of 1 horse-power per 50lbs. dead weight of machine, and hence the great advantage of electro motors for movable machinery.

Now let us turn our attention to our store of power which is converted into mechanical motion by the agency of electricity. I have told you that telegraph engineers use the potential energy of separated zinc and oxygen, but this store is an uneconomical one to draw on, seeing that the maximum amount of work obtainable from the combustion of a certain quantity of zinc cannot exceed the two-hundredth part of the maximum amount of work obtainable from the burning of a quantity of coal having the same money value. The energy of coal is the store we draw from when we wish to work a steam engine or a gas engine, and is also the store we shall mainly employ in driving electric motors. That is to say, coal will be burnt to produce mechanical motion, the mechanical motion will work a magneto or dynamo electric machine to produce an electric current, the electric current will be conveyed along the wires, and at the other end by means of an electro motor, the electric current will be re-converted into mechanical work. You have here the whole process in operation going on before your eyes, from the burning of the gas at the one end to the re-conversion of the energy of the electric current into mechanical work at the other. [Experiment shown].

Instead of converting the electric current energy into mechanical motion I can convert it into heat, and I shall then have, as you see, the ordinary electric light.

Now what will happen if the steam or gas engine does not run quite steadily, or if the strap slips, or, worst of all, if the engine breaks down altogether. Why there is, as you see, a corresponding fluctuation in the speed of the distant motor or in the brightness of the electric light. Slight

* Lecture delivered at the London Institution, on Thursday, March 2, by Professor W. E. Ayrton, F.R.S.

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variations that would otherwise occur in the speed of the engine can be avoided by having a heavily-rimmed fly wheel attached to it, or, better still, by attaching a heavily-rimmed fly wheel to the dynamo or magneto machine itself. This latter plan is adopted in some cases where dynamos are driven by gas engines and the fly wheels may be seen whirling round with their rims going at the rate of a mile a minute. But let the strap give way, or let the engine break down, and no fly wheels can, of course, keep up the speed of the dynamo. The electric motor at the other end must stop, or the electric light go out. Only the other evening, for example, a whole building lighted by electricity was suddenly plunged into darkness during a meeting, owing to a serious leakage suddenly occurring in the cover of the slide valve of the engine. An electric accumulator is then what is needed, a reservoir which has been drinking in the electric energy when the engine was going at its best and which will now give it out when the engine has stopped. Again apart from accidental fluctuations in the speed of the engine or total breakings down there is another most important use for the electric accumulators. That the electric lighting of towns will become general, I need hardly stop to prove to you, and that it will be carried out in ways quite different from the expedients temporarily adopted is also equally obvious. The users of electricity are in this country nearly in the same condition as Robinson Crusoe was with respect to this clothes. Here everyone at present has to manufacture his own electricity if he wants any just as Robinson Crusoe had to make his own boots. But were there companies actually supplying electricity on a large scale as there are companies supplying water, and companies supplying gas, we should lay on a wire to our houses with as little hesitation as we lay on a water supply.

The greater part of the gas that is burnt is consumed, probably, between 6 and 11 p.m.; that is, in five hours out of the twenty-four. But, as no doubt you know, the gas is practically always being made and stored in the gasometers. If, from the non-existence of stores for gas, it were necessary to make, between 6 and 11 p.m., all the gas consumed in that time, the gas generators would require to be much larger, and, consequently, more expensive, so that the interest on capital sunk in the gasworks, and the consequent price of gas, would be much greater. And so it must be with electric lighting plant; if it is only used just when the light is required, it must be much larger and more costly than would be otherwise necessary if it could be kept constantly working, and the electric energy generated during the hours of daylight stored up. Now the experience of two years has shown that, for large buildings, the electric light is far cheaper than gas. How much cheaper will it, then, become when the electric energy can be manufactured at any time convenient, and stored until it is required to be used.

The earliest form of accumulator was simply a voltameter worked backwards. If two pieces of platinum be immersed in dilute sulphuric acid, and a current sent from one to the other, the liquid is decomposed, hydrogen being given off at the one plate and oxygen at the other. If, now, the main current be stopped, and the plates of the voltameter connected with a galvanometer or any instrument for detecting an electric current, it will be found that the voltameter now acts as a battery, sending back a current in the opposite direction to that in which the original current was passed. I connect the plates of this voltameter with the galvanometer; there is no deflection—that is, no current. The current from this battery is sent for a few seconds through the voltameter, and the gases, as you see, are rapidly produced. I stop the current which is decomposing the liquid, and again connect the voltameter plates with the galvanometer, and you see that the voltameter now acts as a battery, because the two platinum plates are in a different electric state one from the other. [Experiment shown.]

But the platinum plates have not much power of storing electric energy, seeing that the work done by the current is chiefly occupied in liberating free oxygen and hydrogen which ascends out of the liquid, whereas it is only that portion of the gas which remains on the plates, or which is dissolved in the liquid in the immediate neighbourhood of the plates, that is effective in producing the return current. Sir William Grove found by a series of most interesting experiments carried out in this very building that coating the plates with what is known as platinum black—a sort of spongy platinum—immensely increased the efficiency of such a secondary battery.

For any cell to be able to send a very strong current it must have a very low resistance—that is, offer a very small opposition to the passage of a current. One of the ways of attaining this is by putting the plates very near together. One of the reasons, indeed, why the resistance of a Grove cell is so much less than that of a Daniell, and, consequently, why it produces so much larger current through a small resistance, is because the plates are so much nearer together. But, if the plates are very near together, there must be some porous partition placed between them, otherwise the liquids will mix together and very little current will be produced. For example, if, in the voltameter, the two platinum plates were near, all the liquid between the two plates would be about equally saturated with oxygen and hydrogen by diffusion, and there would not be much more reason for the secondary or return current to be sent in one direction rather than in the other.

It is clear, then, we must arrange matters so that the passage of the primary current forms on each plate a substance which has no tendency to wander over to the other. Such a substance must obviously be a solid, and a solid not soluble in the liquid. Now, an oxide of lead satisfies, in a marked degree, these conditions, and hence the employment in secondary batteries of this oxide, produced usually by sending an electric current between the lead plates immersed in dilute sulphuric acid.

But, in addition to having the plates near together, they must have large surface, in order to store much electric energy. And the way to give the plate a large surface, without making it inconveniently large, is to make it spongy. Hence what is aimed at is two spongy lead plates near together.

Now Planté made spongy lead plates thus: he placed two or more sheets of ordinary lead in dilute acid, and sent a current from one to the other. This produced brown peroxide of lead on one plate, and liberated hydrogen at the other. After a while the cell was discharged by allowing it to send by itself a current through an external circuit. The effect of this was to reduce the peroxide to spongy lead and to oxidise the other plate, one action which was continued by again sending a current through the cell from an extraneous source, only in this case in the opposite direction from that in which the first charge or current was sent. Reverse currents were now sent in succession for longer and longer times, the cell being discharged between the sending of each, also for longer and longer periods, until at length, after some months, a "well-formed" Planté cell was the result. To subsequently charge it when required, a current is sent through it in one direction only, and a return current is produced when the cell discharges.

But Planté's cell, wonderful as it is, does not store so very much electric energy, and it requires much patience and trouble to originally "form." Indeed, the time required is so great that they have hardly ever been used for any commercial purpose.

In 1880 M. Faure thought of the device of putting a thick layer of red lead on his lead plates, a substance which can easily be reduced to spongy lead by the passage of a current. The plates, after being coated with red lead, are then wrapped in flannel jackets and put side by side in a box, every alternate plate being connected together so as to practically form two plates with very large surface very near together. To form the cells reverse currents are sent somewhat in the same way that they are sent in forming the Planté cell, with the exception that only days and not months are required in the formation. The red lead on the one side is reduced to a spongy material, which is probably lead very slightly oxidised, on the other side, it is reduced to lead peroxide. Charging the cell by sending a current in the direction of the last current sent reduces the suboxide to pure lead, and the lead peroxide on the other side to an even more oxidised salt. On using the cell to produce an external useful current the pure spongy lead becomes again slightly more oxidised and the peroxide slightly less oxidised. In fact, there is a small quantity of oxygen which travels backwards and forwards as the cell is charged and discharged.

Now, does such a cell store electricity? No! emphatically no! When charging it, just as much electricity passes out as passes in, and, when discharging it, just as much electricity passes in as passes out.

Imagine a stream of water was turning a waterwheel, and the waterwheel was employed to raise corn up into a granary, the arrangement might be called one for storing corn, but certainly not one for storing water. So a secondary battery does not store electricity, but electric energy.

The pith, then, of Faure's discovery was the mechanical placing of a salt of lead on the leaden plates, the presence of which layer of lead salt enables spongy lead to be produced in a few days, instead of requiring many months, when the spongy lead is electrically formed out of the lead plates themselves by the long passage of electric currents.

The next point to consider is—1st. The storing capacity of such an accumulator; 2nd. Its efficiency; 3rd. Its durability. Now I am, I am glad to say, able to give you more than hearsay evidence on this point, since Professor Perry and myself have been engaged on rather a long series of experiments on this subject. I may mention that we were both rather sceptical about the merits of the Faure accumulator before commencing this investigation since we feared that the reports of its excellent action were almost too good to be true. Our doubts, however, gradually dispelled themselves as the investigation proceeded, and we now are able to add our tribute to its practical value.

Let us take a single example of the storing capacity. A certain cell, containing 81lbs. of lead and red lead, was charged and then discharged, the discharge lasting eighteen hours—six hours on three successive days; and it was found that the total discharge represented an amount of electric energy exceeding 1,440,000 ft. lbs. of work. This is equivalent to 1 horse-power for three-quarters of an hour, or 18,000 ft. lbs. of work stored per lb. weight of lead and red lead. The large curve shows graphically the results of the discharge. Horizontal distances represent time in minutes, and vertical distances foot lbs. per minute of energy given out by the cell, and the area of the curve, therefore, the total work given out. On the second day we made it give out energy more rapidly than the first, and on the third more rapidly than on the second, this being done, of course, by diminishing the total resistance in circuit. During the last day we were discharging with a current of about 25 ampères. But in connection with the storing power there is a very curious phenomenon to which I think not nearly sufficient attention has been directed, and that is the resuscitating power of a Faure cell. When a cell has been apparently completely discharged, and is left for a few hours by itself, it appears to have obtained a new charge. For example, after the 18 hours discharge just referred to, although there apparently was no electric energy left in the cell at the end, it was found that after a few hours' insulation, the accumulator could give a current of over 50 ampères, and produce, therefore, bright flashes of fire. The phenomenon is wonderfully like the invigorating action of sleep. In one case, during our experiments of an extremely rapid and powerful discharge, we found that in subsequent discharges after rest, the cell gave out three times as much energy as it did in the first discharge. The neglect of considering this resuscitating power has doubtless mislead many people who have possibly discharged a Faure cell very rapidly into under estimating its storing capacity. Not getting out, perhaps, so very much energy in the first discharge, they have erroneously concluded that a considerable portion of the energy originally put in had leaked away, whereas in fact, the electric energy really was remaining there in the cell, but their experiments were conducted too hurriedly to allow it to come out. This resuscitating power may be observed even after very short periods of rest, and is of great importance when a large amount of energy is required at the commencement, after periods of rest, as for example in starting a tramcar after each stoppage, and which indeed tells most fearfully on the horses, reducing their working life to only four years.

Secondly, as regards efficiency. The efficiency of an electric accumulator—that is, the ratio of the work put into it to the work given out—depends on the speed with which it is charged and the speed with which it is discharged. If charged or discharged too quickly, a certain amount of power will be wasted, heating the cell itself; since, whenever a current passes through a body, some heat is developed, and the greater the currents the greater the heat—the latter, indeed, increasing much more rapidly than the current. Now, it is possible, in a way I will not at the moment trouble you by explaining, to distinguish between the work given to the cell to produce chemical decomposition and the work wasted by too hurried charging. Similarly, in discharging, it is also possible to find out how much of the electric energy stored up in the cell is wasted in heating it by too hurried discharging. Allowing for such unnecessary waste, experience shows that, for a million foot lbs. of charge discharged with a

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mean current of 17 ampères, the loss in charging and discharging combined need not exceed 18 per cent.; indeed, in some cases, for very slow discharges, we have found it not to exceed 10 per cent. I do not, of course, mean by this, as some people have mistakenly imagined from the published numbers of Professor Perry and myself, that a current of only 17 ampères can be obtained by discharging a single cell; since, of course, far greater discharge currents can be produced if the external resistance be low; indeed, I shall show you a constant discharge of about 70 ampères presently. In speaking of the number 17, I merely mean to say that was the average current when the experiments on the efficiency above referred to were made.

I have said that a cell containing 81lb. of lead and red lead stored 1,440,000 foot lbs. of work. Now, consider what that means. It represents all the energy required to be expended to pull a tramcar containing forty-six passengers over two miles, after allowing for considerable waste of power in the electrical arrangements. The electro-motor need not weigh, as I told you, more than about 200lb. to produce about two horse-power. We have, therefore, this wonderful conclusion, that about 300lb. dead weight contains all the energy and all the machinery necessary for over two miles run of a tramcar with forty-six passengers. Now, is this result actually obtained at present in the tramcar running at Leytonstone, and which is propelled by Faure's accumulators? No; and why? Partly because the electromotor has not been made to suit the accumulators, nor the accumulators the electromotor, nor is the gearing adapted to either.

The cells, as at present made, would not give off their energy quickly enough; hence a greater number are employed, but which, consequently, require to be charged much less frequently than would otherwise be necessary. Indeed, in a ton of the cells, as at present constructed, there is about fifty miles run of a tramcar containing forty-six passengers.

Spacious as is the Lecture Theatre of the London Institution, it is unfortunately not large enough to admit a tramcar. I have therefore done the next best thing to prove to you that the Faure accumulators really contain a vast store of available energy. We have here a circular saw which is now cutting wood over an inch in thickness. As you see the circular saw is driven by that Gramme electromotor, and the electromotor itself is fed by the energy stored up in these accumulators, and which was put into them by a dynamo machine yesterday, on the other side of London.

When the Faure accumulator was first invented, there were various suggestions of electricity being delivered at houses every morning like milk in cans, and the exaggeration of this idea no doubt did something to prejudice the cells in the eyes of the public.

The reason why milk is delivered in cans and brought by carts is simply because the total quantity required is so extremely small. If milk were required to be consumed in large quantities like water is, we should have it sent through pipes and not by cans. The main use of the accumulators will be as stationary reservoirs corresponding with cisterns for water or gasometers for gas. But in certain cases where the accumulators can be used to propel a cart, as in the case of tramcars, not the cart employed solely to carry the accumulators, then there is not the same objection to their being moved about, seeing that the total weight necessary is small compared with that necessary for a steam engine or a compressed air engine for tram lines to develop the same horse power.

Again just as ordinary electromotors are not made to discharge a Faure cell rapidly, so ordinary electric lamps are unsuited for this purpose: and, therefore, although there is enough energy in a 100lb. dead weight of Faure accumulator to give a light of 1,500 candles for thirty minutes, an ordinary electric lamp cannot be illuminated at all by a single cell. Mr. Edison, however, has been turning his attention to this subject, and here is the result of his handiwork, which arrived last night from America, and which is, therefore, shown for the first time in England this evening. This incandescent lamp, as you see, only requires four Faure accumulators to illuminate it, this one eight, and this other one twelve. But must the accumulators be even as large as those I am using on the table? The answer is no, if you do not require them to give out the light for a very long time. Four much smaller boxes would give just as much light as you see at the present moment; but, of course, would not keep the light burning so long. It is, therefore, now possible to have a box of accumulators and an incandescent lamp, and the whole thing quite easily carried by one man.

Last year Professor Perry drew attention, in his lecture at the Society of Arts on the "Future of Electrical Appliances," to the great waste of power that is produced by coal being carried to the steam engine, instead of steam engines being brought to the coal, and the power given out by the engines conveyed to the place where it was commercially required by electricity. Why, said he, should not the coal be burnt at the pit's mouth, or in the pit, or even in that part of the mine where the seams were thickest, and the engines driven by burning it used to work large dynamo machines on the spot, and the power transmitted electrically to any towns where it was required? Again it has been often asked, why should not the wasted power in streams be utilised? At present it is more economical to use steam engines in a town than to do work in the country by means of the streams, and convey the manufactured articles over the hills into the towns; and for that reason one sees the old water-wheels in the neighbourhood of a place like Sheffield being gradually deserted, and the men preferring to pay a higher rent for steam-driven grindstones in the town to a smaller rent for water-driven grindstones in the suburbs. The question then arises, would it be possible to convey economically the power from the coal-pits or from the streams into the towns by means of electricity? And this obviously turns on how much power can be got out of one end of a wire compared with the amount that is put in at the other. I have during this evening been talking of the measurements of electric energy put into or taken out of an accumulator in foot pounds, and you may have wondered how it was possible to measure electric energy in the engineer's unit of foot pounds. In reality it is very simple. The maximum amount of work a waterfall can do depends on two things, the current of water and the height of the fall. In the same way, the work a galvanic cell or accumulator can do depends on two things—the current it is producing and what is called its electromotive force, the latter being analogous with the difference of pressure or head of water. Again, when electric energy is being turned into mechanical work by means of an electro-motor, the energy which is being put into the motor can be measured by the product of the current sent through the motor and the electromotive force maintained between the terminals of the motor. Now here I have two instruments devised by Professor Perry and myself, an Am-meter and a Voltmeter, the one for measuring a strong current and the other a large electromotive force. With these we will now make simultaneous measurement when we allow this motor, which is driving the lathe, and which is itself driven by an electric current, to run at different speeds. First we will start with the motor absolutely at rest by putting a break on it, and ending by allowing it to run as fast as possible.

Experiment performed and the following results were obtained:—

Speed of motor.	Current in Ampères.	Electromotive force between terminals of the motor in volts.	Electric energy put into the motor in foot pounds per minute.	Power wasted by the current heating the wires of the motor in foot pounds per minute.
0	15	15	$15 \times 15 \times 44{\cdot}25$ *i.e.*, 9956·25	$15^2 \times 1 \times 44{\cdot}25$ *i.e.*, 9956·25
Slow.	10	21	$10 \times 21 \times 44{\cdot}25$ *i.e.*, 9292·5	$10^2 \times 1 \times 44{\cdot}25$ *i.e.*, 4425
Fast.	4	28	$4 \times 28 \times 44{\cdot}25$ *i.e.*, 4956	$4^2 \times 1 \times 44{\cdot}25$ *i.e.*, 708

We see in the last case, when the load was light and the speed of the motor very great, there was less than one-tenth of the waste of power arising from the current heating the wires when the speed was very slow. On the other hand, we observe that the electromotive force between the terminals of the motor has been practically doubled.

This simple experiment really points to the solution of economic transmission of power by electricity, and to which Professor Perry and myself have on numerous occasions directed attention. It is, to allow only a very small current to pass through the wires connecting the electromotor with the generator, and to maintain a very great electromotive force between them; since, in this way, the amount of power transmitted can be made as large as we like, and the waste from the heating of the wires from the passage of the current as small as we like.

Reasoning in this way, Sir W. Thomson showed, in his inaugural address last year to the British Association, that, if we desire to transmit 26,250 horse-power by a copper wire half an inch in diameter from Niagara to New York, which is about 300 miles distance, and if we desire not to lose more than one-fifth of the whole amount of work—that is, to deliver up in New York 21,000 horse-power—the electromotive force between the two wires must be 80,000 volts. Now, what are we to do with this enormous electromotive force at the New York end of the wires? Fancy a servant dusting a wire having this enormous electromotive force. You might as well, as far as her peace of mind is concerned, ask her to put a lightning flash tidy.

The solution of this problem was also given by Sir W. Thomson on the same occasion, and it consists in using large numbers of accumulators. All that is necessary to do in order to sub-divide this enormous electromotive into what may be called small commercial electromotive forces is to keep a Faure battery of 40,000 cells always charged direct from the main current, and apply a methodical system of removing sets of 50 and placing them on the town supply circuits while other sets of 50 are being regularly introduced into the main circuit that is being charged. Of course this removal does not mean bodily removal of the cells, but merely disconnecting the wires. It is probable that this employment of secondary batteries will be of great importance since it overcomes the last difficulty in the economical electrical transmission of power over long distances.

I will conclude my lecture by illustrating one of the other important uses to which the accumulator can be applied, and that is the practical lighting of railway trains, which may be seen in daily operation in the Pullman cars on the Brighton line. The most natural method of lighting a railway train would be to attach a dynamo-machine to the axle of one of the carriages, the guard's van for example, and the rotation of which, necessarily very rapid when the train is going fast, would, without the use of any gearing, produce the necessary current. But the difficulty that immediately meets us is that as soon as the train slows, or stops at a station, or in consequence of the signal being against it, the speed of the dynamo-machine will diminish, and the lights will go out. If, however, while the train is going fast the dynamo performs two operations, the one to keep the lights burning, the other to charge a battery of Faure's accumulators on the train, then the electric energy so stored can be applied to maintain the lights while the train is going slowly or stopping. With such an arrangement there would be, of course, an automatic contrivance for disconnecting the dynamo-machine from the circuit when the speed becomes too low, otherwise the Faure's accumulators would simply discharge themselves back through the dynamo-machine.

Imagine now we are in a train which is going slowly, or which has actually stopped, and that the Faure accumulators lying on the floor here is the Faure battery in the train, and which have been charged when the train was going fast; that then it has sufficient store of power to continue lighting is proved, because, on connecting these two wires, those 50 Maxim lamps, kindly lent me by the Electric Light and Power Company, and eight Edison lamps, before you are instantly brilliantly illuminated, each possessing about 40 candle power, and giving, therefore, far more light than is, at present, ever supplied to a whole train of 12 carriages. The light, you observe, is perfectly steady, and is turned on and off at will. Imagine, now, we are in a tunnel in the daytime, and the lights, therefore, burning. We now emerge from the tunnel into daylight. I disconnect the wires, and the lights are instantly extinguished. Again, it may be we are entering a second tunnel. The wires are again connected by the guard, and we have the whole of this lecture-theatre, which represents the train, brilliantly illuminated.

There has been an erroneous impression existing lately, that the Faure accumulator could not produce a constant current of more than 17 amperes; but, that this is a mistake, is clearly seen from the fact that, at the present moment, each of the cells in this room is producing a current of about 75 amperes.

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TO OUR READERS.

Owing to the inconvenience of giving portions of certain Papers that cannot well be divided in consecutive numbers, we have in this issue increased the number of our pages in order to give the several Papers therein complete. Even with this increased number of pages we are compelled to leave over the continuation of our Exhibition report, the next article on "The Theory of Dynamo and Magneto Machines," together with other articles, Correspondence, &c.

THE TELEPHONE DEMORALISED.

It has often been said that as new phases of civilisation come into operation, new forms of crime are sure to follow in their train. It can, no doubt, be urged on the other hand that the discoveries of science do more for the detection of crime than for its actual perpetration. Be this as it may, we are just now made aware of a fresh facility for fraud afforded by one of the most useful as well as the most innocent of our numerous modern inventions. The telephone has been charged with malpractices of a somewhat alarming kind; and although it has escaped, this time, with a fine in a civil court, it ought by rights to have been arraigned in a criminal dock and sentenced as a criminal. To speak more plainly, Professor Bell's invaluable boon to society is being put to malevolent and even fraudulent uses.

The case which has just brought this very provoking fact to light was tried before Mr. Commissioner Kerr on Tuesday last at the City of London Court, and was simply as follows:—A well-known theatrical agent in the City is in the daily habit of receiving orders for tickets for places of amusement, and many of these orders reach him by telephone. About two months ago he was asked through its medium to forward two guinea tickets for a certain morning performance, and the name and number of the correspondent being duly given, the tickets were accordingly despatched. The gentleman who received them, however, had not ordered them; and being apparently one of those fortunate persons to whom complimentary tickets are by no means unfamiliar, he handed the two guineas' worth "to his clerk." In due time the agent's little bill turned up, which, of course, the recipient declined to pay. We say, of course, because were everybody who receives a brace of tickets henceforward to be required to pay for them on the plea that a telephone voice giving the "name and number" ordered them, theatrical agents might straightway enter upon an uncommonly thriving business. If customers were slow in bespeaking, the telephone would do the speaking for them; and if the existing class of agents would not lend themselves to this fraudulent device for pushing sales, it is pretty certain less scrupulous people soon would. This is the more to be apprehended, as many of the theatres nowadays make no difference between their pass tickets and their pay tickets—at least, no difference which the general public can detect.

The interesting question here arises, Who did order the tickets, and what was his motive? It was alleged at the trial that a strong suspicion prevails that the telephone is abused "by designing and fraudulent people very frequently." The plaintiff also stated that orders came to him in the "same way" every day. It is to be hoped that this does not mean that bogus orders for tickets reach him every day; for, if so, the object of the "designing" person in this case must be to compass the ruin of the unlucky agent. Putting a more charitable view on the circumstances as reported, we may class this little affair as an expensive hoax, and not as one of fraud at all. None the less is it a case for serious consideration, seeing that it reveals a state of things rendering the possibilities of fraud, and worse, extremely easy.

We need hardly say that these possibilities are not confined to the vendor or to some designing intruder. The recipient may quite as easily disavow an order actually given. That any subscriber to a telephone wire would be guilty of such meanness is in the highest degree improbable; but the fact that exposure to such a suspicion is possible would be quite sufficient of itself to deter many people from using the telephone with that perfect confidence which it is so desirable to encourage. On this account we have commented thus plainly upon the first case of the kind that has arisen, in order, if possible, that it may be the last.

Mr. Commissioner Kerr, in deciding the case, non-suited the plaintiff, recommending that he should try and find out who it was that defrauded him; and concluded with the highly moral observation that "there are people in the world always ready to take advantage of any new invention for wrong purposes, and it is well the public should be put on their guard." Of course, this is quite true; so true, indeed, that the wonder is it never occurred to the persons chiefly concerned without prompting. And among those persons the Telephone Exchange companies themselves are, it seems to us, by no means exempt from responsibility. Some means of placing the *bona fides* of a telephone message beyond all reasonable suspicion can assuredly be devised without much difficulty; and that it should be speedily effected is made plain by this very instructive warning, where only two pounds and costs were at stake. The next case may be costlier and more criminal.

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WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my last paper I drew attention to the mode in which artificial magnetism results from the application of force to matter in well-defined but different lines.

We can scarcely do otherwise than admit that terrestrial magnetism is, in some way or other, brought about by the mode in which the force of the sun is applied to the earth.

In *The Electrician*, Vol. VII., June 25th, 1881, I briefly referred to a paper I had read at the Physical Society in May, 1880, upon "The Earth's Rotation as Influenced by Solar Energy." I shall now attempt to show that throughout Nature, certainly as far as the earth is concerned—and we have reason to believe the same principle exists throughout the universe—the force of the sun is exerting its power upon and through the crust of the earth in helical directions of a right and left hand character; that the motion of the earth in the highly attenuated medium of interplanetary space results from such an application of indestructible force; and, further, that the particular description of motion which the earth undergoes necessitates the evolution of magnetic polarity in the same direction as that polarity is known to exist, precisely upon the same principle as a diamagnetic copper wire, after being wound into the form of a solenoid, and freely suspended, exhibits the same magnetic properties.

I desire to point out in as brief a manner as possible the mode in which force which has emanated from the sun impinges upon the earth in the line of the ecliptic; and that it assumes different directions as it traverses the earth in accordance with the first law of motion previous to its emerging again as an indestructible force at the magnetic poles.

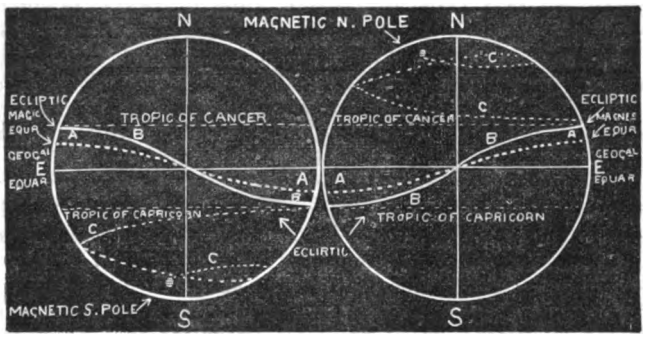

FIG. 7.

Fig. 7 is intended to represent the disposition of the line of the ecliptic and the line of the magnetic equator on the two hemispheres. The curved white line B B B B is the line of the ecliptic marking the sun's path during twelve months, the dotted line A A A A the magnetic equator, the helical dotted line C C C C the extended direction of the force after it has crossed the inter-tropical space.

If the line of the ecliptic be traced from its point of departure from one tropic to the point of reaching the other tropic, it will be seen that the curve to the right or left, as the case may be, is well marked, and that as soon as it has reached one of the tropics it immediately takes a new starting point for a similar curve in the opposite direction to the other tropic. Therefore, as the earth is moving through the lines of force which have been given out by the sun, momenta are being impressed along one of these curved lines, which momenta, according to the first law of motion, must be continued onwards in a straight line, except in so far as they are made to change that direction by the mass of the earth; whilst, by the second law of motion, change of motion must be proportional to the impressed force, and take place in the direction in which the force is impressed. Consequently, the first and second laws of motion co-operate to cause the ejection of this force at one or the other magnetic pole; for the oblique direction in which the force was first impressed is materially increased, first, by the motion of the mass in the opposite direction to that in which the force was impressed, and, secondly, by the shape of the mass; whilst, under the conjoint influence of all the vectors, the force makes its exit at the two magnetic poles, as the resultant of the polygon of forces existent on either side of the ecliptic. Thus it will be seen that the northern projection takes its origin at the tropic of Capricorn, and is ejected at the magnetic north pole; the southern projection takes its origin at the tropic of Cancer, and is ejected at the south magnetic pole, each crossing the equator.

Again, it will be seen, by reference to Fig. 7, that the magnetic equator corresponds with the neutral and oblique line which marks the equator in artificial magnets, and that *the curves which it evhibits are the mean of the curves shown by the line of the ecliptic;* whilst the magnetic poles are the resultant of the polygon of forces acting in both directions from the ecliptic, and in both directions at the magnetic poles, as I have shown occurs in artificial magnetism.

It will be observed further, that, as the earth rotates upon its axis, but never twice in the same plane, such rotations necessarily give rise to the formation of *open eliptical helices* of force,* which are the product of the precessions of the equinoxes and of the earth's nutation.

Here, again, Nature is pointing out the mode in which *continuity of motion and the evolution of terrestrial magnetic phenomena are associated.* And in the artificial production of magneto-electric and electro-magnetic rotations we perceive that the artificial continuity of motion can only be effected by a strict observance of this primary natural law.

Professor Crookes has somewhat recently conducted a series of experiments relative to molecular physics in high vacua, which are very instructive in demonstrating the influence a magnet exercises in deviating lines of energy or electrical discharge when passing from pole to pole in such vacuum tubes. Thus, when the discharge is so passing, and the lines are rendered visible by their phosphorescence, if a small magnet is brought near and moved to and fro, the line of light *becomes curved under the magnetic influence*, the *north pole* gives the ray of molecules a *helical twist one way*, and the *south pole twists it the other way*, whilst the poles side by side compel the ray to move in a *straight line* up or down, along a plane at right angles to the plane of the magnet and a line joining the poles.

It will be perceived that these experiments also tend to prove the identity of the magnetic and electric forms of force; for the electric discharge, when thus rendered visible and subjected to the action of a magnetic pole, behaves precisely in the same way as did the needle point test magnets already referred to, when placed upon the end of one bar magnet and subjected to the action of a similar pole of another magnet.

When we consider that terrestrial magnetic phenomena can be altogether explained as the result of the motion of the mass of the earth through the lines of force impinging upon it from the sun, the nature of that motion, the forward and backward motion of the isogonic lines, the precessions of the equinoxes—the circuit being completed in a period of 26,000 years, or thereabouts—and that the axis of the rotation of the earth, if not determined by the point at which the ecliptic crosses the equator, is isochronous with it, we can scarcely hesitate in adopting the opinion that the magnetic poles must make the circuit of the geographical poles in a period which corresponds with the period of the equinoctial precessions.

It is the province of these papers to give evidence as to the nature of electricity, to explain its connection with magnetism, with the motion of the earth, with gravitation, terrestrial as well as universal, with heat, light, and chemical action, and, in fact, to show the mode in which these various forms or conditions of force result from the operation of one force acted upon by matter under various forms and conditions, and thus to show the *cause* of the laws of gravitation as they are known to exist; and, further, to afford proof that *the entire mechanism of the universe* can be traced to the directive influence which matter exerts upon force. The skill of

* These helices of force may be compared not inaptly to the strands of a ball of twine, which are ever changing their direction obliquely to the right and left, *the terminals being free.*

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the mechanic being manifested in the adaptation of the mechanism to each particular description of work.

Previous to entering upon any details respecting the mode in which the force of the sun maintains the motion of the earth, I may be excused, perhaps, if I call special attention to the well-known fact that the celestial bodies, in common with the earth, are forms of matter of *great density*, the various motions of which are maintained either as systems or as units of a system, in another form of matter of very *great tenuity*, not only without any aggregation, but with regularity and precision. And although Newton in his "Principia" deduced from the observed motion of the heavenly bodies the great fact that they attract one another according to a definite law, he confined himself to the development of the mutual action of bodies, and he said nothing about *the means* by which bodies are made to gravitate towards each other.

I now seek to point out the influence which the sun's force, acting upon the principle of the *double helix*, exercises in the production of the motions of the earth, and at the same time originates *terrestial gravitation*.

I have already shown that the impact of the sun's force is in a direction contrary to the motion of the mass of the earth, and have traced it in the form of right and left-hand helices of force to the magnetic poles, from whence as indestructible force it must again make its exit.

We desire to know why the motion of the planets should result from the action of matter upon matter, and, unless my deductions are erroneous, a clear and definite answer is given by comparing the motions of the earth under the influence of solar force with the behaviour of various bodies under force applied in a similar manner. Hero's steam resistance machine, the hydraulic tourniquet, the electrical whirl, and the radiometer and electrical wheel, as I have ventured to name the latter, both invented by Professor Crookes, are instances of this kind.

The diagram in "Ganot's Physics" representing Hero's resistance machine is a very good illustration of the mode in which force is applied to and makes its exit from the earth, the spirit lamp being substituted for the sun; the heat is applied in a line corresponding with the ecliptic, whilst the energy is emitted at and corresponds to the mode in which it is ejected from the magnetic poles of the earth.

The water which issues from the two tubes of the hydraulic tourniquet rotates the body of the machine precisely upon the same principle, the resistance, as is well known, residing in the unperforated wall of the tube diametrically opposite to the issuing stream, and not, as may be supposed, in the resistance the atmosphere gives to the stream. Consequently, the body rotates in a direction the reverse of that in which the fluid emerges.

The electrical whirl is generally believed to rotate owing to the electricity emanating from the points, originating a similar electrical condition of the air surrounding the points, under which influence both air and points mutually repel. This opinion is supposed to be strengthened by the fact that the rotation will not take place *in vacuo*.

I venture to submit that the phenomenon admits of a very different explanation, and that placing the machine *in vacuo is analogous to closing the apertures of the hydraulic tourniquet*.

The explanation I offer as to the cause of the phenomenon is as follows:—

The electrical aura as it emerges from the points is the result of energy which has been originated in the body of the electrical machine. This energy tends to *fly off by all the conductors*, but the points of the wheel are those channels through which it finds the readiest egress, the greatest tension being at the point and at the angle of the rods. In a vacuum the energy at the point and the energy at the angle balance each other, producing equilibrium. In the atmosphere the electric energy at the point is withdrawn by the molecules of the air, leaving the energy at the corner potent; consequently, the wheel moves in the direction of the prevailing energy; whilst in a vacuum, the energy at the point not being allowed to escape, the balance of power is maintained and motion prevented.

Professor Crookes proves the power molecular impact possesses, when *impressed by the momentum of the electric current*, even in high vacuum tubes, in giving rise to mechanical action.

In one of his vacuum tubes he places a mica wheel, capable of rotating upon its axis, the wheel being provided with a series of vanes, making a sort of paddle wheel. A mica plate is then erected between the wheel and the negative pole, so as to intercept nearly all the molecular stream. The molecules pass over and under the mica plate, and impinge upon the flanges of the wheel *equally*, and no motion takes place; but when a *magnet* is placed over the tube, so as to *deflect* the stream over or under the obstacle, rapid motion will take place in one or the other direction.

The radiometers exhibit the same principle, for, whether the energy falls upon them in the shape of heat or light, they are warmed and then repelled, and in this way each disc is brought under the influence of the energy, and the energy by its action on each fresh surface causes the rotation of the instrument as a whole.

Both in Hero's steam resistance machine and in the electrical whirl we have illustrations of the mode in which the motion of the earth is maintained, for in the earth the energy enters—or in other words, force is impressed—at the ecliptic, and emerges or is given out at the magnetic poles.

This rotation is further promoted by the earth, as it moves on its axis, constantly exposing a fresh, dark, cool, and absorbing surface to the sun's influence, which must act upon the same principle as the radiometer of Professor Crookes.

We thus perceive that the earth is a body which rotates owing to the resistance which its mass offers to the transit of impressed force, that is, exactly upon the same principle as that by which *magnetism* is originated; for the experiment of the late Astronomer Royal—Sir G. Airy—to which I have already referred (*vide Electrician*, June 25, 1881), taken in comparison with the action of other bodies in the production of the same phenomena, appears to prove most completely that *magnetic properties are developed in proportion to the capacity matter exerts for force, coupled with the resistance its molecules offer to the transit of force*, by which means helical direction is imparted to the kinetic energy which results from the impressed force.

But a great and universal law appears at once to unfold itself by this consideration. For, upon the same principle as light is refracted by the medium through which it is being transmitted, so the force which reaches the earth—and of which force light is only one of the primary resultants—is twisted or turned aside in one direction or another by the condition of the diaphonous body.

Further, this force is proved to be *molecular*, or even *atomic*, by the oscillations of the magnetic needle, and by the behaviour of the most minute particles of matter; which as a solid, a liquid, or a gas, can be exposed in the field of an electro-magnet; also to be *universal*, by the varied axes of the planetary system. For, as the axis upon which a planet revolves is intimately associated with its diurnal and annual motion, and with every phenomenon which results therefrom, and the motion of the universe is regulated by a law called the law of gravitation, which is *common to all* matter, we can ascertain the nature of that law by physical research into terrestrial and artificial magnetism.

The law is well known in electro-dynamics that a current of electricity selects by preference the best conducting medium, that is, the medium which offers the least resistance to the passage of the momenta.

When we examine closely the process by which a current of electricity is conveyed from a voltaic couple through a conducting medium, we can readily understand the cause of this well-known law, for so long as the voltaic element is in action, momenta—impressed force—are constantly being made upon the voltaic elements, which momenta must be pushed or driven onwards, according to the rate at which they are impressed and the transmitting power of the conducting medium.

Now, the law of refracting force to which I have already called attention—and which the electro-magnet shows is common to all forms of matter, but varies in each individual

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form—is the primary element in the formation of helical motion, for the refraction of the impressed force must be in proportion to the resistance of the molecular element; consequently, the angle at which it leaves one molecule will determine the angle at which it strikes the contiguous molecule, and so on throughout the mass.

Consequently, it is physically evident that the kinetic energy must traverse the material structure of such a wire or form of matter in lines of a helical direction, the strands of which must be more closely associated as the resistance from deflection increases; and, inasmuch as this deflecting power is general as well as molecular, apart from that element of constitution which gives rise to deflection, we find it is the direct agent by means of which not only all the phenomena of magnetism are effected and regulated, but by which, other things being equal, the angle of inclination of a planet, the motion of a planet, and all the phenomena peculiar to that planet may be determined; for the angle of inclination, taken in connection with the density and the distance, must determine the motion of a planet on its axis, as well as its seasons, together with molecular motion and all phenomena which result from variation in temperature.

We thus perceive how intimately this law of refraction is associated with those molecular changes without which neither vegetable nor animal life could exist.

I shall hope to show in my next paper the influence this helical motion of the force exerts in originating those vibrations which are known to accompany the transmission of the imponderables.—Yours, &c.,

RICH. C. SHETTLE, M.D.

London-street, Reading.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have perused with interest Dr. Shettle's three-and-a-half columns of matter in your number of the 11th inst. While he makes some attempts to turn aside the force of some of my writings published in your columns, yet he altogether avoids noticing that I have published proof that electricity *is matter*, and he proceeds at once to assume that electricity *is not matter, but a force.* In *The Electrician* published 2nd of April last you inserted my offer of a prize of £25 "concerning the nature of electricity," wherein I pointed out that, when an insulated metallic sphere is surcharged with electricity from the prime conductor of a frictional machine, the surcharge or atmosphere of electricity diffuses itself equally all round the sphere, and is invisible, and will remain thus until an uninsulated conductor is brought near to the insulated sphere. The atmosphere of electricity diffused around the insulated sphere no longer remains in that equally diffused state, its particles rush together and become a visible spark at the part of the insulated sphere which is nearest to the uninsulated conductor. These two phenomena—*first*, the equal diffusion and invisibility of the surcharge of electricity around the insulated sphere, and, *second*, the rushing together of that surcharge of electricity to form the compact mass of electricity called a spark—demonstrate *that electricity is a peculiar kind of matter, and cannot be simply a force or energy.* Will Dr. Shettle turn his attention to this subject, and give an answer thereto in your columns?—Yours, &c.,

JAMES JOHNSTONE.

Experiment Rooms, 1, James-square,
Edinburgh, Feb. 13, 1882.

ELECTROLIER OR CHANDELIER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In No. 14, Vol. VIII., page 217, it is asked "If chandelier, why not electrolier?" The answer is, that chandelier has the letter "l," because it is formed from the French word *chandelle*; but in the word electrolier there is nothing to authorise the presence of that letter. The same may be said of the word *gasalier.*—Yours, &c.,

CECIL J. BLACKER.

121, St. George's-road, S.W.

ON THE ELECTROLYSIS OF SULPHATE OF COPPER.*

BY G. GORE, LL.D., F.R.S.

The immediate object of the following research was to examine various conditions connected with the transmission of electric currents through electrolytes, and to ascertain the influence of those conditions on the electro-chemical equivalent of copper; also to observe for any signs of conduction of electric currents by such liquids without electrolysis.

The current employed was obtained from one or more cells composed of amalgamated zinc and platinum in dilute sulphuric acid, and was passed in an undivided state through the series of liquids subjected to electrolysis.

In many of the experiments some difficulty was experienced in ascertaining the exact loss of weight of the anode, in consequence of finely-divided copper falling from it. This powder was in all cases (when anodes of electro-copper were employed) collected, washed in water, then in alcohol, dried, and weighed, and the weight included in that of the anode. With anodes of common copper this was not done, because the powder consisted partly of impurities. In either case an error remained which could not be corrected—viz., the powder which fell off, exposing, as it did, a large surface to the liquid, was somewhat freely oxidised, and also in acid solutions freely dissolved, and its true weight, and, therefore, the true loss of the anode, could not be found. This source of error was unavoidable, and will explain many small discrepancies and inaccuracies which may be observed throughout the research. The accuracy of weighing beyond the first decimal place of figures was not of much value, because the variations due to other causes were always much greater than the trifling inaccuracies of weighing.

EXPERIMENTS.

Experiment 1.—The undivided current from a single cell was passed by means of an anode of commercial sheet copper through an acidulated solution of ordinary cupric sulphate into a cathode of sheet platinum, and by means of a thick anode of pure sheet silver and a cathode of sheet platinum through a solution of pure fluoride of silver, acidulated with pure hydrofluoric acid. Silver was freely deposited.

The deposited silver was in the form of beautifully bright fern-like crystals, and after being washed and dried the weights of deposited metal found were—copper, 1·938 grain; silver, 6·93 grains; theory requiring 6·762 grains. The deficiency of copper, therefore, was 2·03 per cent.

Experiment 2.—To ascertain if the presence of a porous partition had any manifest effect upon the quantity of metal deposited, the undivided current was passed by means of ordinary sheet copper anodes and sheet platinum cathodes of equal dimensions through an acidulated solution of ordinary cupric sulphate; one portion of the liquid being in an undivided glass cell, A, and the other in a cell, B, divided by an earthenware porous septum. The quantities of copper deposited in the two vessels were as follow:—

Weights of Deposit.

	UNDIVIDED CELL. A.		DIVIDED CELL. B.
1st Day,	24·64 grains	...	24·502 grains.
2nd ,,	22·62 ,,	...	22·554 ,,
3rd ,,	32·979 ,,	...	32·683 ,,
4th ,,	22·340 ,,	...	22·016 ,,
Totals	102·579		101·755

The average proportion of weight of A to B was 100 to 99·19.

At the end of the second day the difference of level caused by osmose in the divided cell B was about ¼ inch. The liquid in contact with the cathode was the highest, and had lost much colour, whilst that with the anode had become more blue, and contained crystals of the sulphate. The electrodes in the two divisions and the direction of the current were then reversed. The deficiency of weight of the deposited metal in the divided vessel was apparently not due in any degree to the osmose, because it was not much affected by reversal of the electrodes and direction of current; but it appeared to be increased by the altered chemical composition of the two portions of the electrolyte.

Experiment 3.—To ascertain the effect of an excess of uncombined acid the current was passed during nine days through the usual acidulated solution, A, of cupric sulphate, and through a similar solution, B, containing much less of the copper salt and a much larger proportion of free sulphuric acid. The gains of weight of pure coherent copper by the sheet platinum cathodes were as follow:—

	USUAL SOLUTION. A.		ACID SOLUTION. B.
1st	weighing 1·258 grains		1·313 grains.
2nd	,, ·787 ,,		·791 ,,
3rd	,, 2·656 ,,		2·598 ,,
4th	,, 7·617 ,,		7·614 ,,
5th	,, 17·920 ,,		17·900 ,,
6th	,, 21·802 ,,		21·799 ,,
7th	,, 3·890 ,,		3·697 ,,
8th	,, 11·488 ,,		11·500 ,,
9th	,, 15·277 ,,		15·277 ,,
	Totals 82·695		82·489

The average proportion of weight of A to B was as 100 to 99·74.

From these results I conclude that the proportion of free acid had no great effect upon the quantity of copper deposited by equal currents; the average gain of weight was, however, slightly the greatest in the least acidulated solution.

Experiment 4.—In this experiment the effect of addition of a free neutral salt instead of an excess of free acid, was examined by passing the current through the usual acidulated solution A, and through a mixture, B, of three measures of that liquid, two of a saturated solution of sodic sulphate, and

* Reprinted from the *Proceedings* of the Birmingham Philosophical Society, Vol. iii., p. 24.

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one of water. The deposits of copper were firm, and their weights as follow :—

	A.	B.
1st weighing	10·503 grains	10·575 grains.
2nd ,,	11·121 ,,	11·154 ,,
Totals	21·624	21·729

In this case also the least acidulated liquid yielded a slightly greater deposit. The relative gain of B to that of A was as 100 to 100·49. Dilution of the depositing liquid, therefore, by a solution of sodic sulphate appeared to increase the average proportion of deposit.

Experiment 5.—In order to find the effect (if any) of difference of magnitude of immersed surface of the platinum cathodes, the undivided current was passed through two equal portions of the acidulated cupric sulphate solution, into a cathode A, 2½in. by ½in., and into one B, 2½in. by 2½in.; the copper anodes being of equal surface. The following weights of good copper were deposited :—

	SMALL CATHODE. A.	LARGE CATHODE. B.
1st weighing	16·372 grains.	16·023 grains.
2nd ,,	11·692 ,,	11·493 ,,
Totals	28·064	27·516

The relative gain of A to that of B was as 1 to ·980. I conclude from the result of this experiment that the smaller weight of copper found upon cathode B was due to the larger amount of surface of that cathode, allowing a greater amount of copper to be redissolved by the free acid. (Compare Experiment 36).

Experiment 6.—The influence of simple dilution with water was now tried. One liquid, A, consisted of the acidulated solution of cupric sulphate, and the other, B, of two measures of that solution and one and a half measures of water. All the other conditions were alike. The following were the weights of good copper obtained :—

	USUAL SOLUTION. A.	DILUTE SOLUTION. B.
1st weighing	12·707 grains.	12·732 grains.
2nd ,,	23·983 ,,	24·067 ,,
Totals	36·690	36·799

The relative average gain of A to that of B was as 1 to 1·003. Dilution, therefore, with water was attended by a slight increase in the proportion of deposited copper, probably in consequence of the redissolving power of the free acid being thereby a little diminished.

Experiment 7.—In this experiment the single undivided current from two cells was passed through a series of seven liquids in separate cells with anodes of sheep copper and cathodes of sheet platinum of equal magnitude of surfaces (except in C). Equal volumes of the liquids were employed, and the composition of them was as follows :—

A.—Twelve measures of acidulated cupric sulphate solution, three of sulphuric acid, and six of water.

B.—Normal solution of acidulated cupric sulphate three measures, saturated solution of sodic sulphate two, and water one measure.

C.—The usual acidulated solution of cupric sulphate containing a large cathode.

D.—The usual cupric solution 13½ measures, water 10½ measures.

E.—The ordinary cupric solution only.

F.—The usual cupric solution three measures, a nearly saturated solution of ammonic alum two measures, and one measure of water.

G.—Three measures of the usual cupric solution, one of glycerine, and two of water. The following weights of good copper were deposited :—

Gain of Weight.

	Acidulated Solution. A.	Na_2SO_4 B.	Large Cathode. C.
1st weighing	8·577 grs.	8·578 grs.	8·278 grs.
2nd ,,	5·223 ,,	5·335 ,,	5·206 ,,
3rd ,,	4·489 ,,	4·512 ,,	4·441 ,,
Totals	18·289 grs.	18·425 grs.	17·925 grs.

	Dilute Solution. D.	Ordinary Solution. E.	Ammonic Alum. F.	Glycerine. G.
1st weighing	8·435 grs.	9·401 grs.	8·477 grs.	9·433 grs.
2nd ,,	5·332 ,,	5·331 ,,	5·324 ,,	4·421 ,,
3rd ,,	4·475 ,,	4·481 ,,	4·500 ,,	4·503 ,,
Totals	18·242 grs.	19·213 grs.	18·301 grs.	18·357 grs.

Remarks and Conclusions.—The amount of deposit in the acid solution A was less than that in the usual mixture, as in Experiment No. 3. The result of a comparison of B and E disagrees with that of the similar Experiment No. 4; the proportions of solution of sodic sulphate were, however, somewhat different. The influence of a large cathode (C) was to reduce the proportion of deposit, as in Experiment No. 5. The effect of a dilute solution in D was the reverse of that found in Experiment No. 6. The effect of dilution, either with water (D), with a solution of ammonic alum (F), or of glycerine (G), was to diminish the proportion of deposit. The apparent absence of agreement in the instances mentioned was probably due to the impurities of the anode and those of the solution.

Experiment 8.—To try the effect of long distance asunder of the electrodes, and also of isolating the liquid around the cathode from that around the anode, the undivided current was passed through the usual cupric solution and electrodes of equal size in three successive glass vessels.—A, the ordinary cell with the electrodes about 1½in. apart; B, a glass cell of 17½in. long, 1¼in. wide, and 1¼in. deep; and C, a large glass U tube 6½in. high and 1in. inner diameter. The action was slow, and the liquid around the cathode in the bent tube became lighter in colour during the process. The weights of deposit, after about 126 hours action, were as follow :—

	ORDINARY CELL. A.	LONG CELL. B.	BENT TUBE. C.
1st weighing,	4·894 grains.	4·800 grains.	4·862 grains.
2nd ,,	9·092 ,,	8·858 ,,	9·378 ,,
Totals ...	13·986 grains.	13·658 grains.	14·240 grains.

The order of increasing weight of deposit was exactly the reverse of that of increased surface of liquid, and therefore suggests that the current was partly employed in deoxydising some ingredient of the solution. This circumstance has since been examined in Experiments Nos. 23-27 and 30, but the supposition has not been confirmed.

Experiment 9.—The undivided current was in this case passed through a series of four liquids in separate cells—viz., A, containing the usual cupric solution; B, 5ozs. of that solution diluted with 7 fl. ozs. of water; C, 6 fl. ozs. of it, 1½ fl. oz. of sulphuric acid and 4½ozs. of water; D, 6ozs. of it, 4ozs. of saturated solution of sodic sulphate and 2ozs. of water. In this case, all the cathodes were sheets of platinum, each having an immersed portion 3in. long and 2½in. wide. Each of the sheet copper anodes had an immersed surface 2½in. long and 1½in. wide. Only a slight deposit of copper was found on the backs of the cathodes. The weights of deposit were as follow :—

Gains of Weight.

	ORDINARY SOLUTION. A.	DILUTE SOLUTION. B.	ACIDULATED SOLUTION. C.	Na_2SO_4 SOLUTION. D.
1st gain,	21·093 grs.	21·196 grs.	21·180 grs.	21·105 grs.
2nd ,,	22·613 ,,	22·741 ,,	22·670 ,,	22·698 ,,
3rd ,,	16·860 ,,	16·905 ,,	16·798 ,,	16·852 ,,
4th ,,	19·455 ,,	19·286 ,,	19·197 ,,	19·300 ,,
Total gains,	80·021 grs.	80·128 grs.	79·845 grs.	79·955 grs.

A comparison of A and B shows a slight increase of the deposit in the diluted solution agreeing with Experiment 6, but disagreeing with Experiment 7. Comparison of A and C shows a less deposit in the solution, with an excess of acid and water, similar to E compared with A in Experiment 7. A compared with D shows a slight decrease in the solution containing sodic sulphate similar to B compared with E in Experiment 7.

Experiment 10.—In order to ascertain with greater certainty the effect of glycerine, the current from two cells in series was sent through A, the usual acidulated solution; B, a mixture of 1½ fl. oz. of that solution, ½ fl. oz. of glycerine, and 1oz. of water; and C, a mixture of 2ozs. of the usual cupric solution and 1½ fl. oz. of glycerine. The weights of the deposits were as follow :—

Gains of Weight.

	USUAL SOLUTION. A.	DILUTE GLYCERINE. B.	GLYCERINE. C.
1st gain	2·648 grains	2·643 grains	2·647 grains.
2nd ,,	12·668 ,,	12·680 ,,	12·662 ,,
	Total 15·316 grains	15·323 grains	15·309 grains.

Conclusion.—The glycerine had no conspicuous effect upon the amount of deposit.

Experiment 11.—In another trial of the effect of glycerine, the current from a single cell was passed through a mixture, A, consisting of 1 fl. oz. of the usual cupric solution and 1½ fl. oz. of water; and B, 1 oz. of the usual cupric solution, 1 oz. of glycerine, and ½ fl. oz. of water. The weights of deposited copper were :—

THE USUAL SOLUTION DILUTED. A.	DILUTE GLYCERINE SOLUTION. B.
Gain of weight, 8·993 grains.	... 9·064 grains.

Remark.—The results agree very nearly with those of Experiment 10, and with those obtained with solution D and G in Experiment 7.

Experiment 12.—The effect of the current from a single cell upon the following mixtures was also tried :—A, the usual solution; B, 1½ fl. oz. of that liquid, and 1½ fl. oz. of a saturated solution of borax; C, a mixture of 1½ fl. oz. of the usual solution and 1½ oz. of water, the mixture being saturated with boracic acid, and ½ oz. of water then added; D, 2 fl. ozs. of the cupric solution, 1 oz. of water, and ½ oz. of concentrated propionic acid; and E, a mixture of 1 fl. oz. of the usual cupric solution and 2 ozs. of water, the mixture being saturated with borax, and then ½ oz. more water added. The weights of deposited copper were as follow :—

Gains of Weight.

	USUAL SOLUTION. A.	WEAKER BORAX SOLUTION. B.	BORACIC ACID. C.	PROPIONIC ACID. D.	STRONGER BORAX SOLUTION. E.
1st gain	1·137 grs.	1·208 grs.	1·172 grs.	1·206 grs.	
2nd ,,	2·718 ,,	2·850 ,,	2·848 ,,	2·824 ,,	2·842
Totals	3·855 grs.	4·058 grs.	4·020 grs.	4·030 grs.	

Remarks.—Each of the mixtures B, C, D, and E yielded a slightly larger amount of deposit than the ordinary solution; but in what way they operated to produce this effect I have not fully investigated; possibly by retarding the oxidation of impurities in the liquid. The effects of employing a pure solution are shown in Experiment 18, and in some of the subsequent ones; and the influence of oxidation has been examined in Experiments 27 and 30.

I now examined the influence of temperature and other circumstances upon the *chemical* corrosion of the copper electrodes in a variety of experiments.

Experiment 13.—In this case the undivided current was passed during nine hours through equal volumes of the usual acidified cupric solution in two glass vessels, the one portion, A, being kept at a temperature of about 60deg. F., and the other, B, at about 160deg. F., the portions of water

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evaporated being frequently replaced and the liquid stirred. The weights of copper deposited were :—

COLD. IN A.	HOT. IN B.
16·107 grains.	14·800 grains.

Being a relative difference of 100 to 91·8.

Remarks and Conclusions.—This difference at once showed a marked influence of temperature upon the weight of deposit, nearly nine per cent. less copper being deposited per unit of current in the hot liquid than in the cold one. The inference I draw from this is—that the deposited copper was redissolved by chemical action to a greater extent in the hot solution than in the cold one. These results have a manifest practical application, and show the unadvisibility of using a *hot* sulphate solution for the electro-deposition of copper.

Experiment 14.—In this experiment the object was to compare the amounts of chemical corrosion of the cathode at different temperatures with that of copper in a similar liquid, not subjected to the influence of an electric current. The undivided current was passed, during two days, through two similar portions of the depositing solution, as in Experiment 13, one being at 50deg. F., and the other varying from 175deg. to 188deg. F. Two other portions of the liquid being in similar vessels, each containing a sheet of deposited copper of the same amount of immersed surface as the cathodes, but without a current, were kept at those temperatures respectively during the same period. The weights found were as follow :—

WITHOUT CURRENT.

Cold Copper.	*Hot* Copper.
Loss ·080 grain.	Loss 4·578 grains.

The relative difference of loss of weight was as 1 to 57·225.

WITH CURRENT.

Cold Cathode.	*Hot* Cathode.
Gain of weight, 25·561 grains.	Gain of weight 21·624 grains.

The relative difference of gain of weight was as 100 to 84·59.

Remarks and Conclusions.—From these numbers it appears that the loss of weight of the hot copper plate without a current was 4·498 grains more, or 5·6 times as great as that of the cold one; whilst the gain of the cold cathode was 3·937 grains or 18·16 per cent. greater than that of the hot one. It appears also from this, either that a considerably less amount of copper was deposited per unit of current from a hot solution than from a cold one, or that a much greater amount was redissolved by purely chemical action in the hot electrolyte than in the cold one.

Experiment 15.—The object of this experiment was to ascertain whether the undivided electric current, from a single cell, had the power of preventing the chemical corrosion and solution of a copper cathode in an acid liquid, or of neutralising the effect of such action, by depositing the copper as fast as it was dissolved. The liquid employed was a mixture of ten volumes of distilled water and three of pure sulphuric acid, and was put into two similar glass vessels. The two anodes were of sheet platinum, and the cathodes of sheet copper of equal size; one of the portions of liquid was kept at 54deg. F. and the other at 200deg. F. For the purpose of comparison, two similar portions of the liquid, without an electric current, were placed in two other glass vessels, each containing a sheet of copper of the same size as the cathode; these portions were also kept respectively at 54deg. and 200deg. F. The experiment was continued 8¼ hours; during the first 3¾ hours the cathodes and comparison sheets employed were of ordinary copper, and during the remaining 4½ hours of electro-deposited copper of the same dimensions. The following were the results :—

WITHOUT CURRENT.

Cold liquid at 54deg. F.

Ordinary copper lost	·074 grain	or	·0197 grain per hour.
Electro deposited copper lost ...	·038 ,,	or	·008 ,, ,,
Difference	·036 grain		·0189 grain ,,

Hot liquid at 200deg. F.

Ordinary copper lost	·980 grain	or	·261 grain per hour.
Electro deposited.....	1·430 ,,	or	·316 ,, ,,
Difference	·450 grain		·055 grain ,,

WITH CURRENT.

Cold liquid at 54 deg. F.

Ordinary copper cathode lost ...	·162 grain	or	·043 grain per hour.
Electro deposited ,, ...	·072 ,,	or	·016 ,, ,,
Difference	·090 grain		·027 grain ,,

Hot liquid at 200 deg. F.

Ordinary copper lost	1·362 grain	or	·3632 grain per hour.
Electro deposited.....	1·528 ,,	or	·3390 ,, ,,
Difference	·166 grain		·0242 grain ,,

*Remarks and Conclusions.**—The pieces of ordinary copper in the hot solutions only were reddish at the end of the experiment, especially that which was a cathode. The hot portions of the liquid were of a pale green colour; and no copper was found upon either of the cathodes in the hot or cold liquids. No gas was visible at the electrodes.

A.—WITH AND WITHOUT A CURRENT.

Both common and electro-copper chemically dissolved in the hot liquid and in the cold one, and faster in the former than in the latter.

B.—IN HOT LIQUID AND IN COLD ONE.

Both common copper and electro-copper when used as a cathode dissolved chemically faster than the same copper without a current.

C.—WITHOUT A CURRENT.

Common copper dissolved 13·2 times faster, and electro-copper 39·75 times faster in the hot liquid than in the cold one.

D.—WITH A CURRENT.

Common copper dissolved chemically 8·45 times faster, and electro-copper 21·19 times faster as a cathode in the hot liquid than in the cold one.

E.—IN THE COLD LIQUID.

Common copper dissolved chemically 2·26 times faster, and electro-copper 2·00 times faster as a cathode than without a current.

F.—IN THE HOT LIQUID.

Common copper dissolved chemically 1·39 times faster and electro-copper 1·07 time faster as a cathode than without a current.

G.—TEMPERATURE AND CURRENT.

Whilst a rise of temperature of the liquid from 54deg. F. to 200deg. F. (or 146 F. degrees) caused common copper to dissolve 13·2 times, and electro-copper 39·75 times faster, the electric-current employed only caused common copper to dissolve 8·45 times and electro-copper 21·19 times faster than without a current.

H.—COMMON AND ELECTRO-COPPER.

Without a Current.—Common copper dissolved 2·46 times faster than electro-copper in the cold liquid, and electro-copper dissolved 1·2 times faster than common copper in the hot liquid.

With a Current.—Common copper dissolved chemically 2·7 times faster than electro-copper in the cold liquid, and 1·07 time faster than it in the hot liquid.

These results further confirm the conclusion that instead of a weak electric current protecting a copper cathode from chemical corrosion, it indirectly increases that corrosion; not, however, by setting free at the cathode surface the acid of the decomposed salt. A possible reason why, in all cases, the cathode copper dissolved faster than the copper which was not a cathode, would be that hydrogen may have been evolved in the former case, but not in the latter, at the surface of the copper, and stirred up the liquid. This effect, however, must have been extremely minute, because no evolution of hydrogen was visible. There is no reason to suppose that any alteration of the proportion of water to free acid took place at the cathode, and affected the speed of corrosion.

The results also show that the rise of temperature employed was nearly twice as influential as the electric current in increasing purely chemical corrosion.

Why, without an electric current, electro-copper dissolved 1·2 time faster than the common copper in the hot liquid I have not examined; nor have I investigated why, when employed as a cathode, common copper dissolved chemically 2·7 times faster than electro-copper in the cold liquid, and only 1·07 time faster in the hot liquid; nor further examined why common and electro-copper, either in the cold or hot liquid, dissolved faster when it was a cathode.

Experiment 16.—An attempt was made to ascertain whether the proportion of chemical corrosion was less with a less powerful acid. The liquid consisted of 12ozs. of distilled water, 1½oz. of cupric acetate, and 1oz. by measure of strong acetic acid. It was divided into four equal portions, A and B, C and D—A and C being at 55deg. F, and the other two kept at 186deg. F. The undivided current was passed through A and B by means of similar anodes and cathodes of electro-deposited sheet copper. The two separate vessels C and D contained similar quantities of the liquid at 55deg. and 186deg. F., and similar sheets of electro-copper, without an electric current, for the purpose of comparison. The current was passed during 8½ hours. The amount of loss of copper by chemical corrosion in C and D without the current was as follows :—

COLD. C.	HOT. D.
Loss, ·030 grain.	Loss, ·080 grain.

Relative difference, 0·0.

The gain of cathodes was—

COLD. A.	HOT. B.
·700 grain.	1·090 grain.

Relative difference, 1 to 1·57.

Remarks and Conclusions.—The results in A and B were not very satisfactory, the deposited copper not being of a good colour. The gain of weight was also greater in the hot liquid than in the cold one, contrary to the usual effect.

Experiment 17.—The chief object of this experiment was to ascertain whether the chemical corrosion was diminished by decrease of acid, the conductivity of the solution being maintained by addition of a neutral salt. The liquid was composed of 3½ fl. ozs. of a mixture of 1 volume of pure sulphuric acid and 3 of water, and 7½ fl. ozs. of a saturated solution of sodic sulphate. Equal portions of the mixture were contained in four glass vessels, A and B without an electric current, C and D with a current. A and C were kept at about 57deg. F., and B and D at 192deg. F. C and D contained anodes of sheet platinum and similar cathodes of electro sheet copper. A and B also contained similar sheets of copper to those in C and D. The experiment lasted 9½ hours. The following were the results :—

WITHOUT CURRENT.

A. Cold.	B. Hot.
Sheet copper lost ·082 grain.	Sheet copper lost 2·056 grains.

Relative difference, 1 to 25·073.

WITH CURRENT.

C. Cold.	D. Hot.
Copper cathode lost ·200 gr.	Copper cathode lost 2·988 grs.

Relative difference, 1 to 14·94.

*Remarks and Conclusions.**—Both the hot liquids had acquired a bluish colour, but no copper was deposited either in the hot or cold solutions.

A.—WITH AND WITHOUT CURRENT.

Electro-copper dissolved both in the hot liquid and in the cold one, and faster in the former than in the latter.

* Compare these remarks and conclusions with those of Experiment 17.

* Compare the remarks and conclusions with those of Experiment 15

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B.—IN HOT LIQUID AND IN COLD ONE.

Electro-copper, when used as a cathode, dissolved faster than the same copper without a current.

C.—WITHOUT A CURRENT.

The electro-copper dissolved 24·89 times faster in the hot liquid than in the cold one.

D.—WITH A CURRENT.

The electro-copper cathode dissolved 14·94 times faster as a cathode in the hot liquid than in the cold one.

E.—IN THE COLD LIQUID.

The electro-copper cathode dissolved 2·42 times faster than electro-copper without a current.

F.—IN THE HOT LIQUID.

The electro-copper cathode dissolved 1·45 times faster than electro-copper without a current.

By comparing the results of this experiment with those of Experiment 15, we find, 1st, that although in this experiment the proportion of free sulphuric acid was only about one-third of that in Experiment 15, the electro-copper cathode still dissolved by chemical action, and no copper was deposited; 2nd, that *without a current* the electro-copper dissolved faster in the hot liquid than in the cold one in the proportion of 1 in the less acid solution to 1·59 in the more acid liquid; 3rd, that *with a current*, it dissolved faster in the hot liquid than in the cold one in the proportion of 1 in the less acid liquid to 1·41 in the more acid one; 4th, that *in the cold liquid* it dissolved faster as a cathode than without a current, in the proportion of 1 in the more acid liquid to 1·21 in the less acid one; and 5th, that *in the hot liquid* it dissolved faster as a cathode than without a current, in the proportion of 1 in the more acid solution to 1·35 in the less acid one.

From these comparative results we may conclude—1st, that the corrosion of electro-copper without a current increased much faster by equal rise of temperature in the more acid liquid than in the less acid one; 2nd, that with a current the chemical corrosion of the electro-copper cathode also increased much faster by equal rise of temperature in the more acid liquid than in the less acid one; 3rd, that the chemical corrosion of electro-copper was increased less by making it a cathode wtth equal strength of current in the more acid solution than in the less acid one in the proportion of 1 to 1·21; and 4th, that this corrosion was increased less by making it a cathode with equal strength of current in the more acid solution than in the less acid one in the proportion of 1 to 1·35.

Further Remarks.—It has already been abundantly proved that ordinary chemical action upon the copper continues, and in an increased degree, whilst it is a cathode. In order, therefore, to ascertain, even in an approximate degree, what weight of deposited copper would be the equivalent of the amount of current passed, this circumstance must be taken into account. As a step towards this object we must first add to the weight of copper deposit actually found the weight of copper dissolved from a similar piece of copper, in a similar liquid, at the same temperature, during the same period of time. It must, however, be remembered that the weight thus obtained is still somewhat less than the true one, because by the act of electrolysis the layer of liquid in immediate contact with the cathode is indirectly rendered more corrosive by removing the salt itself (the acid of it to the anode, and the metal to the cathode) from the dilute free acid in which it was dissolved at that surface, and thus increasing the degree of concentration and the corrosive action of that free acid. In addition to this, the removal of copper by deposition renders the liquid at the cathode specifically lighter, and this causes an upward flow of the solution there, which brings fresh particles of acid into contact with the cathode.*

It does not appear possible to make an exact correction for these differences. To exclude also the possibility of any portion of the current being expended in deoxidising any traces of sulphate of iron in the liquid it is advisable to employ a pure solution.

I now prepared some extremely pure cupric sulphate by taking a quantity of thin sheets of clean ductile electro-deposited copper, adding sufficient distilled water to dissolve it when converted into sulphate, then fully an equivalent amount of pure sulphuric acid to form sulphate, and then adding pure nitric acid occasionally until just sufficient to dissolve the whole. The solution was then evaporated to dryness, every trace of free nitric and sulphuric acids expelled by heat, the white powder redissolved in distilled water and recrystallised a number of times. The dry crystals were employed to form solutions in all the subsequent experiments unless otherwise mentioned.

Experiment 18.—The chief object of this experiment was to approximately ascertain what amount of *chemical* solution of the anode (as well as the cathode) took place. 2½oz. of the pure salt and ½ fl. oz. of pure sulphuric acid were dissolved in sufficient distilled water to form 13oz. by measure. The mixture was divided into four equal portions in similar glass vessels, A and B, C and D—that in A and C being kept at 58deg. F., and that in B and D at 198deg. F. The undivided electric current was passed through A and B only, the other two being for comparison. The four electrodes and two comparison sheets were all of electro-copper, and of equal dimensions and amount of surface of immersion. The current was continued during 8 hours. The following were the results:—

WITHOUT CURRENT.

Cold plate.	Hot plate.
Loss, ·048 grain.	Loss, 4·255 grains.

Relative difference of loss by chemical action, 1 to 90·31.

WITH CURRENT.

Cold anode.	Cold cathode.
Loss, 15·350 grains.	Gain, 14·760 grains.

Relative difference, 1 to 0·961.

Hot anode.	Hot cathode.
Loss, 17·112 grains.	Gain, 11·160 grains.

Relative difference, 1 to ·652.

* For the effects of mechanically stirring the liquid see Experiments 39, 42, 43, and 44.

Remarks and Conclusions.—In Experiment 15, I stated that the amount of true chemical corrosion of the *cathode* was not only equal to that upon a similar piece of metal in a similar liquid at the same temperature during the same period of time *without* a current, but was *greater*, and in the "further remarks" on Experiment 17, I suggested that this was because in the former case the acid in contact with the cathode was rendered less dilute by the electrolytic action. The already well-known phenomena of electro-metallic electrolysis justify the additional inference that the true chemical corrosion at the *anode* is *less* than that upon the separate piece of metal *without* a current, because the acid in contact with the anode is rendered much more rapidly dilute by admixture of newly formed dissolved salt than that in contact with the separate piece of metal. On the other hand, the increase of specific gravity of the liquid near the anode, caused by the formation there of cupric salt, causes a downward flow of the solution and brings fresh particles of acid into contact with the metal. This circumstance, however, has probably much less influence than the other one.

In order, therefore, to arrive at the approximately true amount of electro-chemical action at both electrodes, I assumed as a first step that the amount of chemical corrosion at the cold anode and cold cathode were each equal to that of the separate cold plate, and that the corrosions of each of the hot electrodes and of the separate hot metal were also equal, and I therefore—First, subtracted from the loss of weight of the cold anode, and added to the gain of weight of the cold cathode the loss of weight of the separate cold plate; and, second, I subtracted from the loss of weight of the hot anode and added to the gain of weight of the hot cathode the loss of weight of the hot plate. The following were then the weights:—

Loss of cold anode, 15·302 grs.	Gain of cold cathode, 14·808 grs.
,, hot ,, 12·757 ,,	,, hot ,, 15·515 ,,

As a nearer approximation to the true numbers, I assumed, as a next step (in accordance with the explanations given above, and in Experiments 15 and 17), that the amount of corrosion of the anode was less, and that of the corresponding cathode greater, than that of the separate plate of the same temperature; also that the excess of chemical corrosion of each cathode was equal to the deficiency of such corrosion at the corresponding anode. The correction for this was, of course, made by finding the means of the two numbers in each case; and by making it the following weights were obtained:—

Loss of cold anode, 15·055 grs.	Gain of cold cathode, 15·055 grs.
,, hot ,, 14·136 ,,	,, hot ,, 14·136 ,,

These numbers are still not exact, nor in accordance with the law of definite electro-chemical action, which requires them all to be alike, because the electrodes were in the same circuit during the same period of time, and therefore subject to the same amount of electric current.

The remaining difference is probably due to a marked deficiency of chemical solution of the hot anode, to visible oxidation of the anode, and a small deficiency of chemical corrosion of the hot cathode. It might possibly be also partly due to electro-deposition of hydrogen at the hot cathode, but no signs of it were observed.

Experiment 19.—Made chiefly to check a supposed error in No. 18. The current was continued 4½ hours. The cold plates were at 64deg. F. The other conditions were precisely similar to those of No. 18, and the following were the results:—

WITHOUT CURRENT.

Cold plate.	Hot plate.	Relative difference.
Loss, 0·030 grain.	Loss, 2·430 grains.	1 to 81·00

WITH CURRENT.

Cold anode.	Cold cathode.	Relative difference.
Loss, 11·556 grains.	Gain, 11·132 grains.	1 to ·965.
Hot anode.	Hot cathode.	Relative difference.
Loss, 12·386 grains.	Gain, 9·272 grains.	1 to ·753.

These numbers are consistent with those of the last experiment.

Remarks and Conclusions.—By performing the same arithmetical operations upon these numbers as upon those of the preceding experiment the following were obtained:—

Loss of cold anode 11·526 grs.	Gain of cold cathode 11·162 grs.
,, hot ,, 9·956 ,,	,, hot ,, 11·702 ,,
Loss of cold anode 11·526 grs.	Gain of cold cathode 11·526 grs.
,, hot ,, 10·819 ,,	,, hot ,, 10·819 ,,

All these numbers are also consistent with those of Experiment 18.

Experiment 20.—This experiment was made to test an imagined possible effect of a non-porous partition between the electrodes. The solution was the same as that used in Experiment 19, and was contained in two similar glass cells, with four electrodes of electro-copper. The current was undivided, and continued during 7 hours, and the portions of liquid were all at 57deg. F. One of the vessels was equally divided by a partition of sheet gutta percha, close at the sides and extending to within about an inch of the bottom, so as to perfectly screen the plates from each other. The following were the results:—

CELL WITHOUT DIVISION.

Anode A.	Cathode A.	Relative difference.
Loss, 4·185 grains.	Gain, 4·170 grains.	1 to ·996

CELL WITH DIVISION.

Anode B.	Cathode B.	Relative difference.
Loss, 4·475 grains.	Gain, 4·162 grains.	1 to ·930

Remarks and Conclusions.—In the cell with a division, the anode lost more than in the one without division. In that cell, therefore, the chemical corrosion at the anode was increased. The loss of the anode by chemical corrosion was ·290 grain greater in the divided cell than in the undivided one. I have not investigated the causes of these effects. The difference in the amount of deposit agrees in direction with, but is less than, that with a porous partition in Experiment 2.

Experiment 21.—This experiment was made for the purpose of further examining (see Experiment 8) the influence of *distance* of electrodes, the distance apart of them in one vessel being 1-10th in., and in the other ½in. The electrodes were all alike, and the solution and other conditions were

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as previously. The current lasted 7½ hours. The following were the results :—

NEAR ELECTRODES.

Anode.	Cathode.	Relative difference.
Loss, 7·075 grains.	Gain, 6·627 grains.	1 to ·936.

DISTANT ELECTRODES.

Anode.	Cathode.	Relative difference.
Loss, 7·142 grains.	Gain, 6·730 grains.	1 to ·942.

Remarks and Conclusions.—1. The loss of the anode was greater than the gain of the cathode in each case. This is a necessary result of the chemical corrosion, and is manifest in every experiment yet recorded in this communication. 2. This difference was greater with the near electrodes than with the more distant ones. 3. The total loss of the anode was slightly greater with the more distant electrodes than with the near ones. 4. The gain of the cathode was slightly greater with the distant than with the near electrodes ; this is contrary to the effect obtained with a solution of the less pure salt in Experiment 8 ; the distances apart, however, of the electrodes in that experiment were much greater.

Experiment 22.—As a source of slight inaccuracy occurred in the last experiment the trial was repeated during 4¾ hours, and the following are the results :—

ELECTRODES 1-12TH IN. ASUNDER.

Anode.	Cathode.	Relative difference.
Loss, 16·036 grains.	Gain, 12·021 grains.	1 to ·749

ELECTRODES 1IN. ASUNDER.

Anode.	Cathode.	Relative difference.
Loss, 16·240 grains.	Gain, 12·145 grains.	1 to ·748

Remarks and Conclusions.—These results are almost entirely consistent with those of the previous experiment ; and the conclusions to be drawn from them are the same as those from that experiment, with the exception of the second, which is a little different.

Experiment 23.—This experiment was made for the purpose of comparing the effects of a pure acidulated solution (the same as that used in Experiments 18 and 19) under the same conditions as the solution of the ordinary salt in Experiment 8. The containing vessels employed were the same as in the latter experiment. The anodes were all of the same specimen of electro-deposited copper. The current was continued 50 hours, and the following represent the results :—

1ST—THE ANODES.

Ordinary cell.	Long cell.	Bent tube.
Loss of weight, 4·922 grs. ...	4·794 grs. ...	4·462 grs.

2ND—THE CATHODES.

Gain of weight, 3·845 grs. ...	3·906 grs. ...	3·764 grs.
Differences, 1·077 ,, ...	0·888 ,, ...	0·698 ,,

Remarks and Conclusions.—1st, The relative gains of weight upon the cathodes do not quite agree with those in the corresponding cells of Experiment 8. 2nd, Both the loss of weight of the anode and the gain of weight of the cathode were less in the bent tube than in each of the other vessels, and this differs from the corresponding result in Experiment 8. No conclusion of importance can be drawn from these differences in relation to Experiment 8, or to the purity of the solution.

The relative differences of loss of weight of the anode and gain of weight of the cathode were 1 to ·781 in the ordinary cell, 1 to ·814 in the long cell, and 1 to ·843 in the bent tube. In this respect the bent tube produced an opposite effect to the divided cell in Experiment 20.

Experiment 24.—In this experiment an attempt was made to equalise the corrosive chemical action upon the two electrodes by adopting the following arrangements :—The solution consisted of 13 ozs. by measure of distilled water, 24 minims of pure sulphuric acid, and 2½ ozs. of the pure cupric salt. The electrodes and separate sheets were of electrolytic copper, each piece being 5in. long and ¼in. wide. Two vessels were used—one a long and narrow glass trough containing the electrolyte and the two straight electrodes, and the other a circular cup containing the separate portion of liquid and a similar horizontal strip of copper curved into a circle. The anode was parallel to the cathode, above it, but a little on one side, to prevent particles of loose powder falling upon the cathode. The liquids were at the atmospheric temperature, and the electric current was very feeble.

As a portion of copper powder fell from the anode and adhered to the cathode, fresh electrodes were employed after the current had continued 45 hours ; the current was then renewed, and lasted 31½ hours. The following are the results, representing only the latter part of the experiment :—

WITHOUT CURRENT.

Loss of comparison strip of copper, ·110 grain.

WITH CURRENT.

Loss of anode, 29·480 grs. Gain of cathode, 28·67 grs.

Relative difference, 1 to ·972.

Remarks and Conclusions.—If we take the difference between the gain of weight of the cathode and the loss of weight of the anode, ascertain its percentage (2·85), and compare the latter with that of previous experiments, Nos. 18, 19, 20, 21, and 22, in all of which an *acidulated* solution of *pure* salt was used, we obtain the following results :—

NO. OF EXPT.	LOSS IN GRAINS.	GAIN IN GRAINS.	RELATIVE DIFFERENCE.
18.	Cold anode ... 15·350,	Cold cathode ... 14·760,	or 1. to ·961
,,	Hot ,, ... 17·112,	Hot ,, ... 11·160,	,, ·652
19.	Cold ,, ... 11·556,	Cold ,, ... 11·132,	,, ·964
,,	Hot ,, ... 12·386,	Hot ,, ... 9·272,	,, ·756
20.	Cold ,, ... 4·475,	Cold ,, ... 4·162,	,, ·930
21.	Near ,, ... 7·010,	Near ,, ... 6·627,	,, ·945
,,	Distant ,, ... 7·142,	Distant ,, ... 6·730,	,, ·942
22.	Near ,, ... 16·036,	Near ,, ... 12·021,	,, ·749
,,	Distant ,, ... 16·240,	Distant ,, ... 12·145,	,, ·747
24.	Cold ,, ... 29·480,	Cold ,, ... 28·670,	,, ·972

By comparison of these numbers, and referring to the particulars of the experiments themselves, several conclusions may be drawn—viz., 1st, That a reduction of temperature of the solution is the most influential circumstances in diminishing the chemical corrosion of the two electrodes, and thus making their alterations of weight by electrolytic action approximate to each other ; 2nd, That the conditions of Experiment 24 had a greater effect than those of either of the other experiments in equalising the chemical corrosion upon the two electrodes ; and, 3rd, That the distance asunder of the electrodes in a horizontal direction had but little effect.

Experiment 25.—The object of this one was simply to verify the ordinary theory that the acid with which the copper was united previous to its deposition is not set free at the cathode by the electrolysis ; and also to still further reduce, if possible, the chemical corrosion by employing no free acid in the solution. The electrolyte consisted of 2½oz. of pure cupric sulphate, dissolved in 13oz. of distilled water. The other conditions were the same as those in Experiment 19, the liquid was in four equal portions, two being kept at 56deg. F., and the others at 186deg. F. Four electrodes and two comparison sheets of clean electro-copper, all cut from the same piece were employed. The undivided current from a single cell was passed through one hot and one cold solution during five hours. The results are shown below :—

WITHOUT CURRENT.

Loss of cold plate.	Loss of hot plate.	Relative losses.
·290 grain.	·180 grain.	1 to ·620.

WITH CURRENT.

		Relative
Loss of cold anode.	Gain of cold cathode.	difference.
4·470 grains.	5·685 grains.	1 to 1·271.
		Relative
Loss of hot anode.	Gain of hot cathode.	difference.
3·450 grains.	4·850 grains.	1 to 1·406

Remarks and Conclusions.—After the action the cold plate without a current was of good colour, but the hot one was of dark bluish slate colour. The cold anode was rather dark in colour, but the cathode deposit was normal. The hot anode and cathode (especially the former) were of a bluish slate colour. These deviations of colour from the usual ones were probably due to the liquid not containing any uncombined acid, and show that chemical corrosion is not entirely prevented by employing a non-acid solution.

This experiment was the first in the entire series in which the gain of weight of the cathode exceeded the loss of weight of the anode. Probably this result also may be ascribed to the absence of free acid. Notwithstanding that the cold anode probably lost less, and the cold cathode more, by chemical corrosion than the cold separate plate, viz., ·650 grain ; and the hot anode lost less, and the hot cathode more, than the hot separate plate, viz., ·490 grain ; the gain of the cold cathode exceeded the loss of the cold anode by 1·215 grain, and that of the hot cathode exceeded the loss of its anode by 1·40. As there was no free acid present, the passage of the current could not indirectly, as in previous experiments, either dilute such acid at the anodes or concentrate it at the cathodes, nor thus affect the results in the present experiment. This experiment was also the first of the series in which the loss by corrosion without a current was less in the hot liquid than in the cold one. This circumstance was probably due to the absence of free acid, and would partly account for the excess of gain of the cathodes over the loss of the corresponding anodes both in the cold and hot liquids. The loss of the cold anode was 1·020 grain (or 29·565 per cent. more than that of the hot anode, and the gain of the cold cathode was ·83 grain (or 17·216 per cent.) more than that of the hot cathode. The probably correct explanation of all these results is—First, that copper oxidises both in acidulated and in non-acidulated solutions of cupric sulphate without the aid of a current ; second, that it oxidises more in a hot solution than in a cold one ; third, that in solutions not containing free acids the oxide does not dissolve as freely as in acid solutions ; fourth, that in non-acidulated solutions the loss of weight is less in the hot liquid than in the cold one, because the amount of oxygen united to the copper is greater in the former than in the latter ; fifth, under the influence of a current the amount of oxide upon the anode is increased, whilst that upon the cathode is not increased ; and, sixth, possibly also that in a solution which is both hot and not containing free acid, water is simultaneously electrolysed and the oxygen increases the amount of oxide upon the anode.* All these results confirm the general statement that the inequalities of loss and gain of the two electrodes are largely, if not wholly, due to purely chemical causes.

Experiment 26.—The object of this experiment was also to verify the fact that the acid which was combined with the copper previous to deposition was not liberated at the cathode. The solution employed was the same as in the last experiment, and was contained in the same large bent glass U tube as was used in Experiment 8. The electrodes were of electro-deposited copper, and all alike. The current was obtained from two cells in single series, and was continued during nine days ; then two more elements in series were added, and the current continued ten more days. A thin dark coating formed upon the anode, and fell off on agitating it. The deposit on the cathode was good. A fresh anode was substituted on the ninth day. The liquid around the cathode gradually lost its colour, and became very slightly acid to test-paper by the fifteenth day, whilst that around the anode was neutral. On the nineteenth day the liquid around the anode was very slightly acid, and that around the cathode was very faintly alkaline, and the deposit of copper began to acquire a dark colour. About 20cc. of the colourless liquid was drawn off, evaporated to a small bulk, and then to dryness. It yielded a trace of a white salt of alkaline reaction. The weights obtained were as follow :—

Total loss of anode.	Total gain of cathode.	Relative difference.
67·664 grains.	65·470 grains	1 to ·967.

Remarks and Conclusions.—The results show that the salt contained a minute trace of free acid and of a salt of an alkali metal. As during the corrosion of the anode some of the copper in a state of powder fell from it, lay in the liquid, and was no doubt partly dissolved, and probably partly

* See Experiment 35.

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oxodised, a degree of error was introduced into the weights which could not be corrected.

In accordance with the theory that in electrolysis of a salt the acid element appears at the anode only, and with the fact that a solution of cupric sulphate corrodes copper, we find that in a solution of a cupric salt containing no free acid the cathode is less corroded by purely chemical action than the anode even when the solution is hot, because the liquid around the cathode being gradually deprived of its cupric salt has less corrosive action on the copper.

From the result of this experiment, in which the last trace of copper was deposited in the presence of a minute amount of free acid, and from those of Experiment 15, in which a cathode of electro-copper dissolved to some extent in a more acid mixture and deposition of copper was prevented by ordinary chemical action, notwithstanding the passage of the current, it is evident that in the former case the effect of ordinary chemical corrosion was overpowered by the influence of the current, whilst in the latter case the influence of the current was overpowered by that of ordinary chemical action, and that there must consequently be intermediate relative degrees of chemical action and strength of current at which the influences of the two are equal, and a copper cathode neither dissolves nor receives a deposit of copper in an acidulated solution of cupric sulphate.

Experiment 27.—An attempt was now made to ascertain whether, when employing an acidulated solution of the ordinary cupric sulphate (which not unfrequently contains a small amount of persalt of iron), the weight of the deposited copper was affected by a portion of the current being expended in partly deoxidising the persalt of iron. Two equal portions of the liquid were put into two glass trays, each being 7in. long, 4in. wide, and ¾in. deep. The surface of one portion was wholly exposed to the air, whilst that of the other was entirely covered by a sheet of gutta percha in contact with it. The four electrodes were of similar sheet electro-copper, all alike, and in a horizontal position. The undivided current from a single cell was passed through them during 63½ hours. The following were the results :—

UNCOVERED SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
21·405 grains.	20·017 grains.	1 to ·935

COVERED SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
22·21 grains.	19·38 grains.	1 to ·873

Remarks and Conclusions.—The numbers representing the gains of the cathode are reliable and accurate, and show an increase of deposit amounting to 3·28 per cent. greater in the liquid exposed to the air than in the other. These results do not support the view that the amount of deposited copper is sensibly affected by the small amount of iron salt in ordinary cupric sulphate.* The exact amount of loss of the anodes could not be accurately found, owing to a considerable quantity of loose copper powder having fallen from them.

Experiment 28.—In this case the same vessels and liquids were used as in the previous experiment, the only difference being that the liquid which was previously protected from contact with the air was now completely screened from the light only by placing the cover about half an inch above it. The other conditions remained as before. The current was continued 47 hours. The electrodes were then weighed, and the protecting screen transferred to the other vessels, and the current again continued 74½ hours. At the end of that time crystals of cupric salt had formed upon the anodes. The deposits of copper were good. The following were the results :—

AFTER 47 HOURS.—UNCOVERED ELECTRODES.

Loss of anode.	Gain of cathode.	Relative difference.
17·970 grains.	15·752 grains.	1 to ·876.

COVERED ELECTRODES.

Loss of anode.	Gain of cathode.	Relative difference.
17·670 grains.	15·540 grains.	1 to ·879.

AFTER 74½ HOURS.—UNCOVERED ELECTRODES.

Loss of anode.	Gain of cathode.	Relative difference.
21·690 grains.	19·370 grains.	1 to ·893.

COVERED ELECTRODES.

Loss of anode.	Gain of cathode.	Relative difference.
21·700 grains.	19·570 grains.	1 to ·902.

Remarks and Conclusions.—No marked difference of influence of light could be inferred from these results ; the amount of deposit was, however, somewhat greater (about 1½ per cent.) in the uncovered liquid than in the covered one during the first period of the experiment. A similar result occurred in the previous experiment, the difference in that case being greater, viz., 3·28 per cent. During the second period the result was the reverse, showing that the most deposit, always occurring in the same vessel, was not due to exposing it to or shielding it from air or light.

Experiment 29.—The influence of difference of position of the electrodes upon the degree of chemical corrosion was now tried. The liquid consisted of the acidulated solution of ordinary cupric sulphate, and the electric current was from two cells in single series. The solution was in three separate vessels :—A, an ordinary cell, with the electrodes vertical and face to face ; B, a glass dish, 8½in. long, 6½in. wide, and containing about 1in. deep of liquid, with the electrodes horizontal, flat, and in a line with each other ; and C, a glass trough, 7in. long, 1½in. wide, and containing about 1in. deep of liquid, with the edges of the electrodes upwards, and in a single line. All the electrodes were of electro-copper, and perfectly alike. The undivided current was passed through the three vessels in single series, and continued during 42 hours. The deposits of copper were good. The following were the results :—

A.—VERTICAL ELECTRODES.

Loss of anode.	Gain of cathode.	Relative difference.
28·67 grains.	24·57 grains.	1 to ·857

B.—HORIZONTAL ELECTRODES (FLAT).

Loss of anode	Gain of cathode.	Relative difference.
28·44 grains.	23·80 grains.	1 to ·836

C.—HORIZONTAL ELECTRODES (EDGEWAYS).

Loss of anode.	Gain of cathode.	Relative difference.
27·94 grains.	23·40 grains.	1 to ·834

Remarks and Conclusions.—The anodes, being thin, were much corroded, and the powder which had fallen from them was lost by an accident. No new conclusions in addition to those drawn from the results of previous experiments appear to be capable of inference from these results.

Experiment 30.—The object in the first portion of this experiment was to test more satisfactorily than was done in Experiment 27 the influence of the presence of a persalt of iron in the solution. The liquid was composed of 14fl. ozs. of the acidulated solution of common cupric sulphate (used in previous experiments), containing 70grs. of persulphate of iron dissolved in it in the first part of the experiment, and 35grs. only during the second period. The same two glasses were used as in Experiment 27. One contained the above mixture, and the other the acidulated solution of cupric sulphate only. Neither of the solutions was protected from the air. The current from a single cell was passed during twenty-six hours in the first part of the experiment, and during ninety-sixty hours in the second part. The deposited copper in each case was of good quality. The following were the results :—

First Part of Experiment.

ORDINARY CUPRIC SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
13·46 grains.	12·18 grains.	1 to ·904.

SOLUTION CONTAINING FERRIC SALT.

Loss of anode.	Gain of cathode.	Relative difference.
14·57 grains.	10·72 grains.	1 to ·735.

Second Part of Experiment.

ORDINARY CUPRIC SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
19·43 grains.	16·30 grains.	1 to ·839.

SOLUTION CONTAINING FERRIC SALT.

Loss of anode.	Gain of cathode.	Relative difference.
19·30 grains.	15·29 grains.	1 to ·792.

Remarks and conclusions.—From the results of the first part of the experiment it appears that when the cupric solution contains a considerable or sufficient quantity of ferric sulphate, the amount of deposited copper is perceptibly reduced ; and if we compare the relative losses of anode, and gains of cathode, with those in cold liquids, in Experiments 18, 19, 20, 21, 24, and 26, this effect of the presence of ferric salt appears more clearly. A similar effect is also manifest in cold solutions of Experiments 22, 23, and 25 ; but in those cases it is due to other causes.

Experiment 31.—As the total losses of the anodes in Experiment 29 could not be ascertained, a repetition of that experiment was now made with thicker electrodes. The other conditions were the same as in that trial. The current was continued 101 hours. The deposits were good. The upper surface of the anode in B was covered with crystals of sulphate ; a few crystals also formed on the anode of C. The following weights were obtained :—

A.—VERTICAL ELECTRODES.

Total loss of anode.	Gain of cathode.	Relative difference.
33·00 grains.	30·39 grains.	1 to ·921.

B.—HORIZONTAL ELECTRODES (FLAT).

Total loss of anode.	Gain of cathode.	Relative difference.
34·04 grains.	30·99 grains.	1 to ·910.

C.—HORIZONTAL ELECTRODES (EDGEWAYS).

Total loss of anode.	Gain of cathode.	Relative difference.
33·36 grains.	30·05 grains.	1 to ·900.

Remarks and conclusions.—It is evident from these results that the relative positions of the electrodes affect slightly both the amount of total loss of the anode per unit of current, and also the relative amount of such loss to the amount of gain of the cathode, though probably only in an indirect manner, by influencing the rapidity of chemical corrosion.

Experiment 32.—The effect was now tried of adding 5 grns. of pure solid cupric nitrate to 6 fl. ozs. of the ordinary acidulated cupric solution, such as that used in the earlier experiments. The comparison liquid was the ordinary acidulated sulphate. The other conditions were the same as those in Experiment 30. The electrodes were of electro-copper, and the current was continued 88½ hours. The following were the results :—

ORDINARY SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
15·33 grains.	13·48 grains.	1 to ·879.

SOLUTION CONTAINING NITRATE.

Loss of anode.	Gain of cathode.	Relative difference.
15·87 grains.	13·22 grains.	1 to ·831.

Experiment 33.—To obtain a more conspicuous effect Experiment 32 was repeated, using a solution containing 50 grains of the cupric nitrate instead of five. All the other conditions remained the same. The current lasted 68 hours, and the results were as follow :—

ORDINARY SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
12·02 grains.	9·91 grains.	1 to ·824.

SOLUTION CONTAINING NITRATE.

Loss of anode.	Gain of cathode.	Relative difference.
12·25 grains.	10·28 grains.	1 to ·839.

Remarks and conclusions.—The differences of amounts of deposits were

* Compare results of Experiment 30.

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so small in this and the last experiment that no manifest effect of addition of cupric nitrate could be detected.

Experiment 34.—In this experiment two solutions were compared, the one consisting of the pure neutral one (see Experiment 25), and the other the pure acidified one (see Experiment 18). The electrodes were of deposited copper, and the liquids were at the atmospheric temperature. The undivided electric current was from a single cell, and was continued 64 hours. The following results were obtained :—

PURE NEUTRAL SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
7·33 grains.	6·62 grains.	1 to ·903.

PURE ACIDIFIED SOLUTION.

Loss of anode.	Gain of cathode.	Relative difference.
7·81 grains.	6·50 grains.	1 to ·832.

Remarks and conclusions.—The loss of the anode was least in the neutral liquid, and the difference between the loss of anode and gain of cathode was greatest in the acidified solution (compare with the results of Experiment 25).

Experiment 35.—The chief object in this case was to compare the effects of an equal amount of current upon a cold acidulated solution of pure cupric sulphate and upon a hot neutral one of that salt; also to obtain data for judging whether any of the water of the latter liquid was decomposed by the current. Two different liquids were employed, viz., the solution of pure non-acid sulphate (see Experiment 25), and an acidulated one consist- of 5⅓ ounces of the pure salt, 5½ drachms of pure sulphuric acid, and 28 fl. ounces of distilled water. Eight similar glass vessels, eight electrodes, and four comparison sheets, all of electro-copper, and quite alike, were used. The vessels all contained equal volumes of liquid, and all the sheets of metal were equally immersed. A contained cold neutral solution and a comparison plate; B, hot neutral liquid and a similar plate; C, cold acidulated solution and copper plate; D, hot acidulated liquid and similar plate; E, cold neutral solution with electrodes; F, hot neutral liquid and electrodes; G, cold acidulated solution and electrodes; and H, hot acidulated liquid and electrodes. The experiment lasted seven hours, and the following were the results :—

Without Current.

NEUTRAL SOLUTION.

A. Cold.	D. Hot.	Relative difference.
Loss ·27 grain.	Loss ·15 grain.	1 to ·555.

ACID SOLUTION.

C. Cold.	D. Hot.	Relative difference.
Loss ·49 grain.	Loss 4·38 grains.	1 to 8·94.

With Current.

NEUTRAL SOLUTION.

Anode.	E. Cold. Cathode.	Relative difference.
Loss 3·17 grains.	Gain 3·04 grains.	1 to ·958.
Anode.	F. Hot. Cathode.	Relative difference.
Loss 2·61 grains.	Gain 3·25 grains.	1 to 1·245.

ACIDULATED SOLUTION.

Anode.	G. Cold. Cathode.	Relative difference.
Loss 3·30 grains.	Gain 3·02 grains.	1 to ·915.
Anode.	H. Hot. Cathode.	Relative difference.
Loss 4·96 grains.	Gain ·80 grain.	1 to ·161.

Remarks and conclusions.—After the experiment, the plate in the cold neutral solution, A, was of a good colour, whilst that in the hot one, B, was purple and oxidised. The one in the cold acid solution, C, was darker than that in the hot acid liquid, D, whilst the latter one was of a good colour, any film of oxide formed upon it being more perfectly dissolved. The anode in the cold neutral solution, E, was rather dark in colour by oxidation, whilst the corresponding cathode was of a good colour, the oxide being either reduced, dissolved off, or covered by the deposit. The anode in the hot neutral liquid, F, was of a dark red-brown colour, and somewhat purple by oxidation. The corresponding cathode was quite purple and much oxidised, more so than that in the same liquid without a current, B, and had marks, produced by gas bubbles, upon its surface. The current, therefore, did not prevent oxidation of the cathodes, and consequent increase of weight, any more than it did corrosion by free acid, and decrease of weight. The anode in the cold acid solution, G, was rather dark in colour; but the cathode was quite bright and the deposit good. The one in the hot acid solution, H, had only a slight amount of purple stain of oxide upon the back, whilst the cathode was not visibly oxidised. These phenomena of oxidation largely affect the variations of weight of the plates and electrodes.

By further comparing these results we find :—1st, That *without a current* the loss by corrosion in the cold neutral liquid was to that in the cold acid one as 1 to 1·81: this shows the greater loss of weight produced by the presence of free acid. 2nd, That the loss in the hot neutral liquid to that in the acid one was as 1 to 29·2, showing the great increase of corrosive effect of free acid when heated. This is also conspicuously seen in the great deficiency of deposit upon the cathode in the corresponding liquid (H). 3rd, That *with a current* the corrosion of the anode in the cold neutral liquid was to that in the cold acid liquid as 1 to 1·041; 4th, In the hot neutral liquid to that in the hot acid one as 1 to 1·90; 5th, In the cold neutral liquid to that in the hot one as 1 to ·823; and 6th, In the cold acid liquid to the hot one as 1 to 1·503: 7th, That the gain of the cathode in the cold neutral solution to the cold acid one was as 1 to ·993; 8th, In the hot neutral liquid to that in the hot acid one as 1 to ·246; 9th, In the cold neutral liquid to the hot one as 1 to 1·069; and 10th, In the cold acid liquid to that in the hot one as 1 to ·263. The great corrosive influence of the hot acid solution is shown in conclusions Nos. 2, 4, 6, 8, and 10. In the neutral solution (especially in the hot portion), the losses of the anodes were lessened, and the gains of the cathodes increased by oxidation. The smaller loss of the hot cathode than of the cold one in the neutral solution was probably due to the circumstance that the former gained oxide as well as deposit; and the greater gain of the anode in the hot neutral liquid than in the cold one may be explained by similar oxidation. The reason why the anode in the hot neutral liquid appeared less oxidised than the comparison plate without current in that liquid, was probably because, under the influence of the current, the transferred acid dissolved some of the oxide. The results afforded no conclusive evidence respecting the decomposition of water or deposition of hydrogen.

Experiment 36.—In this case I examined more accurately the influence (if any) which relative amount of surface of the electrodes had upon the deposit. The solution consisted of the pure acidulated cupric sulphate, the same as in Experiment 35, and was contained in two similar glass vessels, the one containing a large anode and a small cathode, and the other a small anode and a large cathode, all cut from one sheet of electro-copper. The large electrodes were each 38mm. long and 25mm. wide, and the smaller ones 25mm. long and and 4·5mm. wide; the proportions of their surfaces were, therefore, as 1 to 8·44. The vessels were in single series; the undivided current from four cells was passed through them during 10½ hours; and two similiar sheets of electro-copper were immersed in a separate and equal bulk of the liquid during the same time. The following were the results :—

WITHOUT CURRENT,

Smaller sheet.	Larger sheet.	Relative difference.
Loss, ·13 grain.	Loss, ·75 grain.	1 to 5·77.

WITH CURRENT.

Small anode.	Large cathode.	Relative difference.
Loss, 6·64 grains.	Gain, 6·40 grains.	1 to ·963.
Large anode.	Small cathode.	Relative difference.
Loss, 6·47 grains.	Gain, 6·39 grains.	1 to ·987.

Remarks and Conclusions.—The chemical corrosion of the comparison sheets was not directly proportional to their amounts of surface, but was relatively less upon the larger surface. The other results confirm the conclusion that the amount of copper deposited per unit of current does not vary with the magnitude of the cathode or with what is termed the "density of the current." Notwithstanding that the chemical corrosion of the large comparison sheet was greater than that of the small one, the greater total loss of the anodes was with the small one, and the weight of deposit found upon the large cathode was not less than that upon the small one. These results indicate that the current indirectly equalised the amounts of chemical corrosion upon the two cathodes.

Experiment 37.—This experiment was made for the purpose of ascertaining whether a thermo-electric current, generated by two thin and perfectly similar ribbons of electro-copper wholly immersed respectively in hot and cold portions of a liquid influenced the relative amounts of their total corrosion. The liquid employed was composed of ten volumes of distilled water and three of pure sulphuric acid, which, after having cooled, was placed in two flat-bottomed glass cups with vertical sides. The cups were about 3¼in. wide and 2in. deep, and each contained 1¼in. deep of the liquid. Each cup was covered by a closely-fitting bung. The liquid in the two cups was connected electrically by a glass syphon of large bore filled with the same mixture. The previously weighed pieces of copper were cut from contiguous parts of a sheet; they were each 18¼in. long and 1in. wide, perfectly and similarly cleaned, and coiled into loose spirals. A narrow strip of the end of each spiral projected above the liquid, and the two strips were connected metallically by means of a copper wire for the purpose of closing the circuit. The liquid in one of the cups was maintained at a temperature of 177deg. F. by means of a lamp, and the other at 66deg. F., and the experiment was continued seven hours.

A precisely similar experiment in every respect, with a second pair of cups, &c., was simultaneously made, except that the circuit was left open. The following were the results :—

LOSSES OF COPPER IN OPEN CIRCUIT.

At 66deg. F. Ribbon A.	At 177deg. F. Ribbon B.	Relative difference.
·15 grain.	·94 grain.	1 to 6·266.

LOSSES OF COPPER IN CLOSED CIRCUIT.

At 66deg. F. Ribbon C.	At 177deg. F. Ribbon D.	Relative difference.
·20 grain.	·66 grain.	1 to 3·300.

Remarks and Conclusions.—I have already shown* that in the closed circuit of such a combination the hot copper is thermo-electro-negative to the liquid, and a current circulates from the cold copper through the intervening solution to the hot copper. From the above results it appears that in the closed circuit the cold anode lost more, and the hot cathode lost less than in the open one.

Experiment 38.—This was an exact repetition of the last one, except that the pair of ribbons, &c., which constituted the closed circuit, now formed the open one; and those which formed the open one, now constituted the closed one. The duration of this experiment was exactly the same as that of the other, and the following were the results :—

LOSSES OF COPPER IN OPEN CIRCUIT.

At 66deg. F. Ribbon C.	At 177deg. F. Ribbon D.	Relative difference.
·10 grain.	·64 grain.	1 to 6·4.

LOSSES OF COPPER IN CLOSED CIRCUIT.

At 66deg. F. Ribbon A.	At 177deg. F. Ribbon B.	Relative difference.
·17 grain.	·75 grain.	1 to 4·41.

Remarks.—The results of this experiment are substantially the same as those of the last one, and again show that closing the circuit reduced the amount of relative difference of corrosion of the two pieces of copper.

* See *Philosophical Magazine*, January, 1857; also *Proceedings of the Royal Society*, Vol. xxvii., No. 188, p. 513; Vol. xxix., No. 199, p. 472; and Vol. xxxi., No. 208, p. 244.

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Experiment 39.—The object of this experiment was to ascertain whether the amounts of chemical corrosion of the anode and cathode were in some degree equalised by stirring the liquid. Three similar glasses were used containing equal volumes of the pure acidulated solution of cupric sulphate employed in Experiment 35. Six similar pieces of clean electro-copper, each one inch wide, cut from the same sheet, were taken, four of them being used as electrodes, and the other two as comparison sheets in the third vessel. All the sheets were immersed about 1½in. deep in the liquid. The current from two cells in single series was passed through the two vessels during 6 hours; and the two comparison sheets A and B were immersed during the same time. The liquid in one only of the electrolytic vessels was continually stirred by means of a slowly revolving vertical spindle, having at its lower end a vertical strip of sheet gutta percha. The following were the results:—

WITHOUT CURRENT.

Sheet A.	Sheet B.
Loss, ·10 grain.	Loss, ·05 grain.

WITH CURRENT.

Anode.	Cathode.	Relative difference.
Loss, 7·64 grains.	Gain, 7·23 grains.	1 to ·946

WITH CURRENT, AND STIRRING.

Anode.	Cathode.	Relative difference.
Loss, 8·04 grains.	Gain, 7·28 grains.	1 to ·905.

Remarks and Conclusions.—The deposited copper was of good quality. The loose powder from the anode in the stationary liquid weighed ·59 grain, and in the stirred liquid ·50 grain, and each are included in the above weights. The powder in the latter being diffused by the stirring, came into contact with the cathode, and some of it adhered and was fixed by the deposited metal, making the deposit in that liquid quite rough and prickly. The quantity so adhering was probably equal to the difference in weight of the two quantities of loose powder, viz., ·09 grain. (See also Experiments 42 and 43).

Experiment 40.—The object in this case was to ascertain whether the loss of weight of the anode and gain of the cathode were more equalised by employing very narrow electrodes. The electrolyte was the same as in the last experiment. The two electrodes were cut from the same piece of electro-copper. The anode was about 2·75mm. wide and immersed 20mm.; the cathode was about 3·5mm. wide, and immersed 24mm. The current was from a single cell and continued 8½ hours. The following were the results:—

Anode.	Cathode.	Relative difference.
Loss, 4·27 grains.	Gain, 4·05 grains.	1 to ·948.

Remarks and Conclusions.—By comparing these results with those of other experiments, it appears that the relative difference is not much affected by narrowness of the electrodes.

Experiment 41.—In consequence of the irregularities of amount of chemical corrosion of the electrodes in various of the foregoing experiments when repeated under apparently the same conditions, extra precautions were taken in the present one to have the surfaces of the metal as alike as possible previous to immersion, by not only taking contiguous portions of the same sheet of copper and cleaning them by immersion in dilute nitric acid, &c., but by immersing them simultaneously in that acid and during exactly the same time. They were then equally immersed vertically in the same portion of pure acidulated solution of cupric sulphate of Experiment 35 during 14 hours. The following were the results:—

Plate A.	Plate B.
Loss, ·055 grain.	·060 grain.

Experiment 42.—As in Experiment 39, the powder from the anode in th stirred liquid got upon the cathode and vitiated the results. Two glass troughs, 9in. long, 1¼in. wide, and 1¼in. deep, were now taken and filled with the same acidulated solution of pure cupric sulphate as in that experiment. Four perfectly similar sheets of electro-copper, prepared as in Experiment 41, were immersed 24mm. deep in the solution, and an undivided current from three cells in single series passed through the two portions of liquid during five hours, the liquid near one of the cathodes being stirred by means of the same contrivance as in Experiment 39. The following were the results:—

WITH CURRENT.

Anode.	Cathode.	Relative difference.
Loss, 2·09 grains.	Gain, 1·98 grain.	1 to ·947.

WITH CURRENT, AND STIRRING.

Anode.	Cathode.	Relative difference.
Loss, 2·13 grains.	Gain, 1·97 grain.	1 to ·924.

Remarks and Conclusions.—These results, as well as the corrected ones of Experiment 39, show that under the influence of stirring the liquid, the gain of the cathode to the loss of the anode is relatively less, and, therefore, that the stirring increased the corrosion of the cathode. In each case also (after the suggested correction in Experiment 39 had been made) the anodes lost more in the stirred than in the unstirred liquid; also after the suggested correction had been made the results of the two experiments were remarkably concordant. Probably the stirring acted in part by increasing the rapidity of chemical corrosion, and partly by removing loosely adherent particles.

Experiment 43.—Another trial was now made to further equalize the ordinary chemical corrosion of the two electrodes, by employing the minimum of free acid. The liquid consisted of 2½ ozs. of pure cupric sulphate dissolved in a mixture of 13ozs. of water and 12 minims of pure sulphuric acid. The influence of stirring the liquid near the cathode only was also examined. The liquid was contained in two glass troughs, each 9ins. long, 1¼in. wide, and 1¼in. deep. The electrodes were formed of contiguous portions of deposited sheet copper, 25mm. wide, and were each immersed 26mm. in the liquid.; they were in each case 8ins. apart. Two similar comparison sheets of electro-copper (A and B), of the same width and depth of immersion, were suspended in a portion of the same liquid in a separate glass cup. The electric current was from three elements in single series, and the experiment was continued 7½ hours. The following were the results:—

WITHOUT CURRENT.

Plate A	Plate B.
Loss, ·04 grain.	Loss, ·025 grain.

WITH CURRENT.

Anode.	Cathode.	Relative difference.
Loss, 2·02 grains.	Gain, 1·90 grain	1 to ·940.

WITH CURRENT AND STIRRING.

Anode.	Cathode.	Relative difference.
Loss, 2·01 grains.	Gain, 1·80 grain	1 to ·895.

Remarks and Conclusions.—The object in stirring the liquid near the cathode only, was to prevent any disturbance of any loose copper upon the surface of the anode and transference of it to the cathode. The results show that stirring the liquid near the cathode increases the loss of copper by chemical corrosion at the cathode. This agrees with the result of Experiments 42 and 44.

Experiment 44.—This was made to ascertain what effect stirring the liquid had upon the ordinary chemical corrosion of copper in the absence of a current. Two similar plates of electro-copper were equally immersed in two equal volumes of solution composed of 5ozs. 2¾ drachms of pure cupric sulphate, 5¾ drachms of pure sulphuric acid, and 28ozs. of water, contained in two separate glass cups. The liquid in one of the vessels was stirred by means of the contrivance already mentioned (see Experiment 39), and the experiment was continned 8¼ hours. The following were the results:—

Stirred Liquid.	Unstirred Liquid.	Relative difference.
Loss of copper, ·17gr.	Loss of copper, ·07gr.	1 to ·411.

Remarks and Conclusions.—The results of this experiment agree with those of No. 42 and the last one, viz., that the stirring increased the amount of ordinary chemical corrosion, probably by bringing fresh particles of acid more rapidly into contact with the copper. By comparison of these results with those of Experiment 43, it appears that the increase of ordinary chemical corrosion was greater in the absence of an electric current than when a current entered the copper as a cathode.

Experiment 45.—This experiment was made to ascertain whether a moderate reduction of temperature had much effect in equalising the loss of anode and gain of cathode. The solution used was the same as in the last experiment, and was contained in three similar glass cells, two of which were at 51deg. F., and the other in a mixture of ice and water at 36deg. F. Each cell contained two sheets of electro-copper, all from the same piece, of equal size and equally immersed. An undivided electric current from two elements was passed through the cold cell and one of the other vessels. The third cell was a comparison one without a current. The experiment lasted eight hours. The following were the results:—

WITHOUT CURRENT.

Plate A.	Plate B.
Loss, ·04 grain.	Loss, ·05 grain.

WITH CURRENT.

Liquid at 51 degs. *F.*

Anode.	Cathode.	Relative difference.
Loss, 5·78 grains.	Gain, 5·50 grains.	1 to ·951.

Liquid at 36 degs. *F.*

Anode.	Cathode.	Relative difference.
Loss, 5·92 grains.	Gain, 5·51 grains.	1 to ·930.

Remarks and Conclusions.—The influence of a variation of temperature at low degrees of heat is probably very much less than at high ones, because at high ones the chemical corrosion itself generates much more heat. The gain of the cathode in the colder portion of liquid was therefore only a trifle more than in the other portion. The probably correct explanation of the results obtained is that the true effect of cold being very small was partly masked by the usual interference, viz., the difficulty of ascertaining the exact amount of loss of the anode.

Experiment 46.—The object in this case was to ascertain if the amount of corrosion of the cathode was diminished, and a nearer approach to the true electro-chemical equivalent of copper obtained, by increasing the density of the current at the cathode. The liquid was composed of 2½ozs. of the pure salt dissolved in 13ozs. of distilled water. The electro copper cathode was 3mm. wide, and was horizontally immersed 38mm. of its length. The electro-copper anode was 1¼in. wide, and immersed 2in. deep. A comparison vessel contained the same solution, and a horizontal strip of of the same electro-copper, 3mm. wide, was immersed 38mm. of its length in it. The undivided current from three cells, in single series, was passed during four hours. The following were the results:—

WITHOUT CURRENT.

Loss of comparison copper ·03 *grain.*

WITH CURRENT.

Anode.	Cathode.	Relative difference.
Loss, 1·85 grain.	Gain, 1·54 grain.	1 to ·832.

Rate of deposit, ·385 grain per hour.

The experiment was now continued during 6¾ hours, with a current from five cells, in series, instead of three. These are the results:—

WITHOUT CURRENT.

Loss of comparison copper ·03 *grain.*

Anode.	Cathode.	Relative difference.
Loss, 5·58 grains.	Gain, 5·52 grains.	1 to ·989

Rate of deposit, ·817 grain per hour.

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This experiment was again continued during 6¾ hours, with a current from a series of ten cells, with the following results :—

WITHOUT CURRENT.

Loss of comparison copper ·01 *grain*

Anode.	Cathode.	Relative difference.
Loss, 11·53 grains.	Gain, 11·26 grains.	1 to ·976

Rate of deposit, 1·668 grain per hour.

Remarks and Conclusions.—The anode did not appear especially oxidised, and the deposited copper was of good colour, though considerably nodular and rough upon the parts of the cathode nearest to the anode. The numerical results are favourable to the conclusion that a considerable density of the current at the cathode enables a nearer approach to be made to the true electro-chemical equivalent in the weight obtained of deposited copper.

Experiment 47.—This experiment was exactly similar to the last, except that an anode of electro-copper, equally small with the cathode, was used, and the undivided current was from a single series of 20 cells, continued three hours. The following were the results :—

WITHOUT CURRENT.

Comparison copper lost ·02 *grain.*

Anode.	Cathode.	Relative difference.
Loss, 9·38 grains.	Gain, 9·29 grains.	1 to ·990.

Rate of deposit, 3·096 grains per hour.

Remarks and Conclusions.—The appearances of the two electrodes and comparison sheet were as satisfactory as in the last experiment, and the numerical results support the conclusion that a considerable density of the current at both electrodes is favourable to obtaining the true electro-chemical equivalent of deposited copper.

General Remarks and Conclusions.—Several general remarks may be made upon the different classes of results, and conclusions of a larger scope may be drawn.

Many of the experiments indicate, and the whole of them are consistent with the general inference, that in all cases of electrolysis the two forces, ordinary chemical and electro-chemical, co-exist and operate independently at the same surfaces of liquid and metal; that ordinary chemical action, both of simple oxidation and of corrosion of both electrodes by free acid, takes place in all cases, and is a phenomenon entirely distinct from, and independent of, electro-chemical corrosion of the anode and deposition upon the cathode. The two classes of phenomena, however, are coincident and affect each other in various indirect and secondary ways. As also the phenomena which occur in the liquids of a voltaic battery are essentially similar to those in electrolysis, similar conclusions may be drawn respecting them, and probably also respecting metals immersed in salts, alkalies, and acids, liquified by fusion. As these two actions are essentially distinct, so must their less fundamental relations also be distinct, except in indirect ways.

In consequence of these two actions being essentially independent of each other, an electric current passing out of a piece of copper into an acid solution does not directly increase the rapidity of ordinary chemical corrosion of the metal, nor does a current entering from such a liquid into a copper cathode protect that metal from such corrosion. As also in an electrolyte undergoing electrolysis, any free acid, or other solvent present, is able to redissolve some of the deposited metal, so is it able to prevent the deposition of that portion of metal, and, therefore, the quantity of copper deficient at the cathode has probably never been deposited.

Some of the experiments (see Nos. 39, 42, 43, and 44) show that stirring the liquid increases the ordinary chemical corrosion both of the anode and of the cathode, and therefore that the technical process of swaying to and fro by mechanical means articles which are being plated in a depositing solution, tends to corrode them. For although the motion of such articles removes less diluted liquid from contact with them, and thus diminishes corrosion, it increases the corrosion in a greater degree by bringing numerous fresh particles of corrosive liquid into contact with them.

As stirring affects the speed of chemical corrosion, so also any chemical or electro-chemical action which causes liquid streams must affect the speed of such corrosion; such streams are produced by both these causes. At the anode both ordinary and electro-chemical action, by causing the formation of soluble salt, and thus increasing the specific gravity of the liquid, cause a downward flow. At the cathode, whilst ordinary corrosion by forming a soluble salt increases the specific gravity and causes a downward flow, electro-chemical change, by depositing copper, decreases the specific gravity, and causes an upward one; and unless the electric current is very feeble the latter overpowers the former.

In accordance with the great general truth that most physical actions tend to bring about a state of things which retards and finally prevents their own continuance, both ordinary and electro-chemical action produce changes of condition which diminish their speed. Without the aid of an electric current a piece of copper corroded by dilute sulphuric acid forms cupric sulphate, which for a time remains in solution in contact with the copper, and by diluting the acid retards the corrosive action until by the combined influence of gravity and diffusion it flows downwards and passes outwards into the bulk of liquid. With a current at the anode, both by ordinary and electro-chemical action, similar results occur; and in this case by contact of undissolved oxide or undiffused saline liquid with the anode, an electric current tends to be generated in a direction opposite to the original one. At the cathode, by ordinary chemical action, changes are produced by which such corrosion is retarded in just the same manner as with a piece of copper into which no electric current is entering; and at that electrode, the liquid being by electro-chemical action deprived of copper, leaves the previously free acid less diluted in contact with the electrode until it either unites chemically with the metal, or, by the combined action of gravity and diffusion, it mixes with the mass of solution, and at the same time the contact of that free acid with the cathode tends to generate an electric current opposite in direction to the original one.

That temperature also greatly influences the chemical corrosion is proved by the numerical results. The higher the temperature the greater was the amount of chemical solution of the hot copper without current, and of the hot electrodes; and for equal rise of temperature, the increase of corrosion appeared to be greater at high temperatures than at low ones, because the corrosion itself produced heat. This effect probably varies in degree, both with different salts of copper, and with other metals. It is more comprehensively shown in the following tables :—

LOSSES OF COPPER BY CORROSION IN HOT AND COLD LIQUIDS WITHOUT AN ELECTRIC CURRENT.

No. of Expt.	Liquid.	In cold Liquid.	In hot Liquid.	Relative difference.
14.	Acidulated sulphate	·080 gr.	4·578 grs.	or 1 to 57·225
15.	,, water	·038 ,,	1·430 ,,	,, 37·63
,,	,, ,, ...	·074 ,,	·980 ,,	,, 11·89
16.	Acetate of copper	·030 ,,	·030 ,,	,, 0·00
17.	Acidulated sulphate	·0826 ,,	2·056 ,,	,, 24·89
18.	,, ,, ...	·048 ,,	4·355 ,,	,, 90·73
19.	,, ,, ...	·030 ,,	2·430 ,,	,, 81·00
25.	Neutral ,, ...	·290 ,,	·180 ,,	,, 1·611
35.	,, ,, ...	·270 ,,	·150 ,,	,, 1·800
,,	Acidulated ,, ...	·490 ,,	4·380 ,,	,, 8·94
37.	Acidulated water	·15 ,,	·94 ,,	,, 6·266
38.	,, ,, ...	·10 ,,	·64 ,,	,, 6·40

It will be observed that in the above table the ordinary chemical corrosion was least affected by heat in the acetate of copper solution, somewhat more so in one of neutral sulphate, still more in acidulated water, and most in acidulated cupric sulphate.

DIFFERENT AMOUNTS OF COPPER DEPOSITED IN HOT AND COLD SOLUTIONS BY EQUAL CURRENTS.

No. of Expt.	Solution.	In cold Liquid	In hot Liquid	Relative difference.
13.	Acidified sulphate ...	16·107 grs.	14·800 grs.	or 1 to ·9188
14.	,, ,, ...	25·561 ,,	21·624 ,,	,, ·8452
16.	Acetate of copper ...	·700 ,,	1·090 ,,	,, 1·557
18.	Neutral sulphate ...	14·760 ,,	11·160 ,,	,, ·7560
19.	,, ,, ...	11·132 ,,	9·272 ,,	,, ·8329
25.	,, ,, ...	5·685 ,,	4·850 ,,	,, ·8531
35.	,, ,, ...	3·040 ,,	3·250 ,,	,, 1·069
,,	Acidified pure ...	3·020 ,,	·800 ,,	,, ·265

An inspection of the above table shows that a considerable deficiency of deposited copper, sometimes amounting to 16 per cent. (see Experiment 14), may result by ordinary chemical corrosion through employing a *hot* solution. This fact is worthy of consideration in the electro-deposition of copper for commercial purposes.

In the three experiments, Nos. 16, 25, and 35, where the cold liquid did not appear to have a less corrosive effect than the hot one, the liquids were either neutral, or contained a feeble acid. The hot copper plates also were of a dull red, or of a purple colour, and evidently oxidised, and this increased their weights and made their losses by corrosion in the hot liquid appear less.

With regard to the bearing of the results of these experiments upon the electro chemical equivalent of copper, the greatest obstacle to finding this number was the difficulty of determining how much the ordinary chemical corrosion was decreased at the anode, or increased at the cathode, by the electric current, and the next greatest obstacle was the disintegration of the anode and the dissolving of the powder by chemical action. Why, or in what manner the powder was formed, I have not yet ascertained; it is, however, a circumstance which occurs with anodes of nearly all metals. A true unit or standard of comparison could not be found either in the weight of loss of anode or gain of cathode. Notwithstanding that the cathode is more corroded than the anode, the gain of weight of the former is the least inaccurate, because of the unavoidable disintegration of the anode. Substantially, the method does not admit of a great degree of accuracy, because the chemical corrosion of copper, even in a cold neutral solution of cupric sulphate (see Experiments 25, 35), causes a loss of copper and prevents the true weight being obtained, and because obstacles appear to arise in every direction and prevent a true and reliable correction being made for the deficiency. The correction cannot be accurately, but may be approximately, found by using a comparison sheet of copper in the same liquid without a current. The corrosion of such a sheet is, however, somewhat less than that of the cathode, because the action at the latter creates a stronger liquid stream, and thus increases the corrosion, and a true correction for this residuary deficiency does not appear to be obtainable. The nearest approach to the true number appears to be obtainable by using a cold neutral solution, small narrow horizontal electrodes, rapid deposition without stirring, continued during only a short period of time, and a strong current. These conditions were best fulfilled in Experiments 18, 19, 24, 46, and especially in 47.

The weight of deposit obtained evidently depends upon a number of conditions, and if an alteration is made in a single circumstance it is difficult to ascertain its exact quantitative result. Much of this want of exactitude appears to depend upon the employment of comparatively large electrodes.

No signs were observed in any of the experiments of ordinary electric conduction unattended by electrolysis.

The following Table contains a summary of the relative losses of anode, and gains of cathode, in the various experiments for more convenient reference :—

Table of Differences of Loss of Anode and Gain of Cathode.

No. of Experiment.	General Conditions of Experiment.		Loss of Anode.	Gain of Cathode.	Relative difference.
18.	Pure Acidulated Solution of the Copper Salt.....	Cold ...	15·35 grs.	14·76 grs.	1 to ·961
,,	Pure Acidulated Solution of the Copper Salt.....	Hot ...	17·112 ,,	11·160 ,,	1 to ·652
19.	Pure Acidulated Solution of the Copper Salt.....	Cold ...	11·556 ,,	11·132 ,,	1 to ·965
,,	Pure Acidulated Solution of the Copper Salt.....	Hot ...	12·386 ,,	9·372 ,,	1 to ·753
20.	Same Liquid, with Non-Porous Partition	Cold ...	4·185 ,,	4·170 ,,	1 to ·996

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No. of Experiment.	General Conditions of Experiment.		Loss of Anode.	Gain of Cathode.	Relative difference.
20.	Same Liquid, without Non-Porous Partition	Cold ...	4·475 grs.	4·162 grs.	1 to ·930
21.	Same Liquid, with Near Electrodes	,, ...	7·075 ,,	6·627 ,,	1 to ·936
,,	Same Liquid, with Distant Electrodes	,, ...	7·142 ,,	6·730 ,,	1 to ·942
22.	Same Liquid, with Near Electrodes	,, ...	16·036 ,,	12·021 ,,	1 to ·749
,,	Same Liquid, with Distant Electrodes	,, ...	16·240 ,,	12·145 ,,	1 to ·748
23.	Same Liquid, with Near Electrodes	,, ...	4·922 ,,	3·845 ,,	1 to ·781
,,	Same Liquid, with Distant Electrodes	,, ...	4·794 ,,	3·906 ,,	1 to ·814
,,	Same Liquid, with Bent Tube	,, ...	4·462 ,,	3·764 ,,	1 to ·843
24.	Faintly Acid Solution—Horizontal Electrodes	,, ...	29·480 ,,	28·670 ,,	1 to ·972
25.	Non-acid Solution of the Pure Salt	,, ...	4·470 ,,	5·685 ,,	1 to 1·271
,,	Non-acid Solution of the Pure Salt	Hot ...	3·450 ,,	4·850 ,,	1 to 1·406
26.	Same Solution in Bent Tubes	Cold ...	67·664 ,,	65·470 ,,	1 to ·967
27.	Ordinary Acidulated Solution, uncovered	,, ...	21·405 ,,	20·017 ,,	1 to ·935
,,	Ordinary Acidulated Solution, covered	,, ...	22·21 ,,	19·38 ,,	1 to ·873
28.	Ordinary Acidulated Solution, screened from Light	,, ...	17·67 ,,	15·54 ,,	1 to ·879
,,	Ordinary Acidulated Solution, not screened from Light	,, ...	17·97 ,,	15·752 ,,	1 to ·876
,,	Ordinary Acidulated Solution, screened from Light	,, ...	21·70 ,,	19·57 ,,	1 to ·902
,,	Ordinary Acidulated Solution, not screened from Light	,, ...	21·69 ,,	19·37 ,,	1 to ·893
29.	Ordinary Acidulated Solution, Vertical Electrodes	,, ...	28·67 ,,	24·57 ,,	1 to ·857
,,	Ordinary Acidulated Solution. Horizontal Electrodes—flat	,, ...	28·44 ,,	23·80 ,,	1 to ·836
,,	Ordinary Acidulated Solution, Horizontal Electrodes—edgeways	,, ...	27·94 ,,	23·40 ,,	1 to ·834
30.	Ordinary Acidulated Solution alone	,, ...	13·46 ,,	12·18 ,,	1 to ·904
,,	Ordinary Acidulated Solution, with 70 grains of persalt of Iron	,, ...	14·57 ,,	10·72 ,,	1 to ·735
,,	Ordinary Acidulated Solution alone	,, ...	19·43 ,,	16·30 ,,	1 to ·839
,,	Ordinary Acidulated Solution, with 35 grains of persalt of Iron	,, ...	19·30 ,,	15·29 ,,	1 to ·792
31.	Ordinary Acidulated Solution, Vertical Electrodes	,, ...	33·00 ,,	30·39 ,,	1 to ·921
,,	Ordinary Acidulated Solution, Horizontal Electrodes—flat	,, ...	34·04 ,,	30·99 ,,	1 to ·910
,,	Ordinary Acidulated Solution, Horizontal Electrodes—edgeways	,, ...	33·36 ,,	30·05 ,,	1 to ·900
32.	Ordinary Acidulated Solution alone	,, ...	15·33 ,,	13·48 ,,	1 to ·879
,,	Ordinary Acidulated Solution, with 5 grains of Cupric Nitrate	,, ...	18·57 ,,	13·22 ,,	1 to ·831
33.	Ordinary Acidulated Solution alone	,, ...	12·02 ,,	9·91 ,,	1 to ·824
,,	Ordinary Acidulated Solution, with 50 grains Cupric Nitrate	,, ...	12·25 ,,	10·28 ,,	1 to ·839
34.	Pure Neutral Solution	,, ...	7·33 ,,	6·62 ,,	1 to ·903
,,	Pure Acidulated Solution	,, ...	7·81 ,,	6·50 ,,	1 to ·832
35.	Pure Neutral Solution	,, ...	3·17 ,,	3·04 ,,	1 to ·958
,,	Pure Neutral Solution	Hot ..	2·61 ,,	3·25 ,,	1 to 1·245
,,	Pure Acidulated Solution	Cold ...	3·30 ,,	3·02 ,,	1 to ·915
,,	Pure Acidulated Solution	Hot ...	4·96 ,,	·80 ,,	1 to ·161
36.	Pure Acidulated Solution Small Anode and Large Cathode	Cold ...	6·64 ,,	6·40 ,,	1 to ·963
,,	Pure Acidulated Solution Large Anode and Small Cathode	,, ...	6·47 ,,	6·39 ,,	1 to ·987
39.	Pure Acidulated Solution	Cold ...	7·64 grs.	7·23 grs.	1 to ·946
,,	Pure Acidulated Solution, Liquid stirred	,, ...	8·04 ,,	7·28 ,,	1 to ·905
40.	Pure Acidulated Solution Narrow Electrodes	,, ...	4·27 ,,	4·05 ,,	1 to ·948
42.	Pure Acidulated Solution	,, ...	2·09 ,,	1·98 ,,	1 to ·947
,,	Pure Acidulated Solution Liquid stirred near Cathode	,, ...	2·13 ,,	1·97 ,,	1 to ·924
43.	Pure Solution, very slightly acid	,, ...	2·02 ,,	1·90 ,,	1 to ·940
,,	Pure Solution, very slightly acid, Liquid stirred near Cathode	,, ...	2·01 ,,	1·80 ,,	1 to ·895
45.	Pure Acidulated Solution	,, ...	5·78 ,,	5·50 ,,	1 to ·951
,,	Pure Acidulated Solution	Chilled	5·92 ,,	5·51 ,,	1 to ·930
46.	Pure Neutral Solution, Large Anode and Small Cathode	Cold ...	1·85 ,,	1·54 ,,	1 to ·832
,,	Pure Neutral Solution, Large Anode and Small Cathode	,, ...	5·58 ,,	5·52 ,,	1 to ·989
,,	Pure Neutral Solution, Large Anode and Small Cathode	,, ...	11·53 ,,	11·26 ,,	1 to ·976
47.	Pure Neutral Solution, Small Anode and Small Cathode	,, ...	9·38 ,,	9·29 ,,	1 to ·990

The chief technical results of this research are—that a considerable deficiency of deposited copper, sometimes amounting to as much as 18 per cent. (see Experiments 13 and 14), is caused by using a hot solution, or one with too much free acid in it, or by stirring the liquid in contact with the cathode. (See Experiment 42). The research also supplies information respecting the degree of accuracy of the method of measuring by means of electrolysis of a solution of cupric sulphate, the amount of electric current consumed in electric lighting, and states the conditions under which the degree of inaccuracy of measurement is the least. The author is now investigating the influence of an electric current upon the purely chemical corrosion of anodes and cathodes.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices March 8.		Business Done Week Ending March 8. Highest.		Lowest	
Anglo-American	50,	51	.....	50¼	.....	47⅛
Do. Preferred	79,	80	.....	80	.....	76½
Do. Deferred	21,	22	.....	21⅛	.....	19
Brazil Submarine	11,	11½	.....	11½	.....	11½
Cuba	8½,	9	.....	—	.....	—
Do. Preference	15½,	16½	.....	—	.....	—
Direct Spanish	5¼,	5¾	.....	5¾	.....	5 9-16
Do. Preference	15,	15½	.....	15½	.....	15½
Direct United States Cable	10½,	10¾	.....	10¾	.....	10
Eastern Telegraph	10,	10¼	.....	10¼	.....	9 15-16
Do. 6 per Cent. Preference	12½,	12¾	.....	12¾	.....	12⅛
Do. 5 per Cent. Debentures, 1899	102,	107	.....	—	.....	—
Eastern Extension	10½,	11½	.....	11½	.....	11
German Union	9¼,	9½	.....	9½	.....	9⅛
Globe Telegraph and Trust Company.	6¼,	6½	.....	6¼	.....	6
Do. Preference	12½,	12⅞	.....	12¾	.....	12
Great Northern	12,	12½	.....	12¾	.....	11⅛
Indo-European	28,	29	.....	28¼	.....	28¼
Mediterranean Extension	2,	2½	.....	—	.....	—
Do. Preference	8¼,	9½	.....	—	.....	—
Reuter's	12½,	13	.....	—	.....	—
Submarine	260,	270	.....	—	.....	—
West India and Panama	1½,	1⅝	.....	1⅝	.....	1⅝
Do. 1st Preference	7½,	8	.....	7⅝	.....	7⅛
Western Brazilian	8½,	8⅞	.....	8¼	.....	8⅛
West, Union 7 per Cent. 1st Mortgage	123,	128	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	101,	104	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1⅝	.....	1⅝	.....	1 5-16
Oriental	⅞,	1	.....	7-16	.....	7-16
United Telephone	13½,	13¾	.....	14	.....	13⅜

ELECTRIC LIGHT.

Electric Light and Power	⅜,	½	.....	15-16	.....	13-16
Anglo-American Brush	9,	9¼	.....	9¼	.....	9⅛

TRAFFIC RECEIPTS FOR FEBRUARY, 1882.

Companies.	Feb., 1882.	Feb., 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Cuba Submarine Company	3,200	2,867	333	—
Direct Spanish Telegraph Company	2,109	1,876	233	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	27,473	28,021	—	548
Eastern Telegraph Company	44,046	46,463	—	2,417
Great Northern Telegraph Company	17,000	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,475	1,700	1,775	—
West India and Panama Telegraph Company	—	—	—	—

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SLIP

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 10th instant amounted to £3,915.

ELECTRIC LIGHT AT INDIANAPOLIS (U.S.A.).—It is stated that the lines of the Union Railway Company through Indianapolis are to be lighted by electricity.

ELECTRIC LIGHTING FOR MINES.—Electric lighting, so says a Spanish contemporary, has been adopted for some time in the Rio Tinto mines with satisfactory results.

ELECTRIC LIGHT IN BOSTON (AMERICA).—According to an American contemporary electric lights are being introduced into the House of Representatives at Boston.

METEOROLOGICAL SOCIETY.—An interesting collection of meteorological apparatus is now on view at the rooms of this society. The exhibition will close on Tuesday next.

TASMANIA.—News from this colony says that a reduction in the rates of telegraphic messages to the other Australian colonies was to take place on and after the 1st February.

THE TELEPHONE IN PHILADELPHIA.—When the telephone exchange in Philadelphia was commenced in November, 1878, it had only 15 wires; now it has 605 wires and 850 subscribers.

ELECTRIC LIGHTING FOR CLERKENWELL AND ISLINGTON.—The Vestries of both these parishes have appointed committees to inquire into the cost and practicability of the electric light for street illumination.

DIVIDEND.—The directors of the Brazilian Submarine Telegraph Company have declared an interim dividend of 3s. per share. The transfer books of the company will be closed from the 18th to the 24th instant.

SOCIETY OF ENGINEERS.—The discussion on the paper entitled "Notes on Electric Light Engineering" will be resumed at the above society's rooms, 6, Westminster Chambers, on Monday next, at 7:30.

ELECTRIC LIGHT AT EASTBOURNE.—The Eastbourne Local Board at a recent meeting gave permission to the newly-formed Electric Light Company to open the streets for the purpose of laying the necessary wires.

THE QUEEN AT MENTONE.—During the Queen's stay at Mentone her villa will be in direct telegraphic communication with London, a special wire having been erected by the French Government for Her Majesty's use.

FAURE'S BATTERY.—Owing to the pressure on our space we are compelled to leave over the full report of the experiments with Faure's secondary battery, recently presented to the French Academy of Sciences, till our next issue.

TRANSMISSION OF POWER.—We understand that Professor Sylvanus Thompson will lecture at the Crystal Palace on Wednesday week next on the above subject. This lecture will be in continuation of the series recently delivered by him.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 10th March, 1882, were £2,722, after deducting the "fifth" of the gross receipts payable to The London Platino-Brazilian Telegraph Company.

SOUTH AFRICAN TELEGRAPHS.—The revenue derived from the telegraphs in Cape Colony during the half year ended 31st December last was £32,205 1s. 3d., as compared with £23,370 7s. 8d. in the corresponding period of 1880, being an increase of £8,834 13s. 7d.

COLLECTING TELEGRAMS AT RAILWAY STATIONS.—The *Glasgow Herald* of a recent date announces that the Post Office authorities have authorised the railway companies to collect public telegrams at the St. Enoch, Queen-street, and Central Stations of that town.

CRYSTAL PALACE ELECTRICAL EXHIBITION.—A reception will be given on the 22nd by the Presidents of the Chemical Society and the Institute of Chemistry at the Palace. On Wednesday last the exhibition was visited by Prince Edward of Saxe Weimar and the officers of the Portsmouth garrison.

ELECTRIC LIGHT IN MILAN.—The lighting of the Ridotto della Scala by Edison incandescent lamps continues (says *La Lombardia*) to be greatly admired. Mr. Shepherd, the representative of the Edison Company in Milan, has lately demonstrated the adaptability of the system to street lighting in the Via Filodrammatici.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting will take place at 25, Great George-street, S.W., at 8 p.m. on the 23rd inst., when a paper will be read "On the Development of a New Telephonic System," by Professor A. E. Dolbear, Professor of Physics, Tufts College, Boston, Mass.

SOCIETY OF ARTS.—The paper on "Telephonic Communication," by Colonel Webber, announced for reading at the Society of Arts on the 22nd March, has been postponed. We understand that the alteration has been made in consequence of the Chemical Society's Conversazione, which is to be held the same evening at the Crystal Palace.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of February was 3,347, estimated to produce £3,200, against 2,692 messages, producing £2,867, in the corresponding month of last year. The traffic receipts for the month of December, estimated at £2,500, realised £2,741.

PREPAID TELEGRAMS.—On Thursday, in the House of Commons, Mr. Alderman Lawrence was to ask the Postmaster-General whether he does not consider that it would be of great advantage to the public, and profitable to the Post Office, if a prepaid reply telegram of ten words were issued on payment of an additional 6d. to the price of the telegram sent.

THE ELECTRIC LIGHTING BILLS.—The knowledge that the Government is going to deal with the various electric lighting bills has so far influenced the Corporation of Glasgow that they are likely to withdraw the electric-lighting clause of their Gas Bill. Power will probably be reserved, however, if that can be done, to reintroduce it in the event of the provisions of the expected Government measure not proving locally satisfactory.

THE ORIENT LINE.—The ss. "Cotopaxi," belonging to this splendid line, has been fitted with Swan lamps. There are altogether fifty lamps. This is, we think, the first vessel in which such lamps have been placed in the cabins. Travellers will be only too glad to get rid of the oil lamp from the cabin, where, at the best of times, the ventilation is none too good. We believe the work was carried out by Messrs. R. E. Crompton and Co., under the superintendence of Mr. Shoolbred.

ELECTRIC LIGHT AT MANCHESTER.—It is stated that the electric lights which have been in use for nearly a year now at the Victoria Station, Manchester, have been pronounced a failure by the Lancashire and Yorkshire Railway Company. On several occasions the station has been left in darkness when trains have arrived, and the unsteadiness of the light has been very great. One night, recently, on the arrival of a

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heavy train, the engine driving the dynamos broke down, and the lights went out.

ELECTRIC LIGHTING IN INDIA.—The municipalities in India seem to be taking kindly to electric lighting, and even thus early the Eastern Electric Light and Power Company have entered into a contract to supply both arc and incandescent lighting for the public streets of Broach under the Brush system. Negotiations are also pending with a number of other cities, including Bombay, where in the Crawford Market the company, by arrangement with the municipal authorities, are erecting an experimental display.

ELECTRICAL APPARATUS ON FRENCH RAILWAYS.—According to the Paris correspondent of the *Standard* of the 14th inst., the Eastern Railway Company recently made trial of a train equipped with the most recent and improved electrical apparatus which ran from Paris to Gretz. "The carriages were connected by electric communications, the brakes acted by electricity, and all the compartments of the thirteen carriages composing the train were lighted by electric lamps. The results of the experiments were completely satisfactory."

ELECTRIC LIGHT FOR STOCKTON (YORKS.).—The *Yorkshire Post* says that the Stockton Corporation have decided to oppose the several electric lighting Bills now before Parliament. The Corporation have a monopoly of the lighting of the town at present, and having a large sum—upwards of £100,000—invested in gasworks, they desire to protect their interests by preventing, if possible, the acquisition of power by any electric lighting company to light the borough publicly. The electric light is already in use in several local works.

ELECTRIC LIGHT IN NORWICH.—Some curious people in Norwich having taken upon themselves to make personal investigation of the wires erected for electric lighting purposes in this town, a placard offering a reward of £5 for their detection has been issued. What they expected to extract from the wires we do not know, but should they injure the insulating cover, and should the current be on at the time, these curious people would probably receive such a shock as would impress them with a greater respect for other people's property in future.

THE TELEPHONE IN MONTREAL (CANADA).—At the annual meeting of the Bell Telephone Company, held at Montreal, the chairman congratulated the shareholders upon the successful results of their business, which had enabled them not only to write off the whole of the preliminary expenses account and put aside 5,000 dollars to meet unforeseen contingencies, but also to pay 6 per cent. dividend on the capital of the company, and carry a balance of between 4,000 dollars and 5,000 dollars forward to next year.—*Liverpool Journal of Commerce.*

EXHIBITION AT BORDEAUX.—*La Lumière Electrique* says that at the approaching exhibition to be held at Bordeaux a special space will be set apart for electrical apparatus. The Compagnie des Telephones of Paris intend to open an office in the exhibition buildings, where visitors will be able to listen to the performances of the principal theatres of Bordeaux. There will also be an electrical tramway running, similar to that in use at Paris. The car will run on the ordinary tram lines from the Place de la Comédie to the interior of the exhibition.

TELEPHONES IN SOUTH AMERICA.—Buenos Ayres, the wealthy centre of the River Plate trade, is already surpassing many large commercial towns in Europe in its use of the telephone. The Pantelephone Company (System L. de Locht), formed some months ago, has proved a great success, having already over 600 subscribers, 200 of whom are in communication, the remainder to be brought in in a few weeks, as the works are farther advanced. This company has opened fifteen offices, where the public can not only speak but also hand in written messages.

CENTRAL AND SOUTH AMERICAN CABLE.—Mr. M. Hamilton Gray, F.G.S., engineer-in-charge of the India Rubber, Gutta Percha, and Telegraph Work Company's ss. "Silvertown," telegraphs the arrival of that vessel on 10th March at Madeira. The "Silvertown" has on board 2,371 nautical miles of cable, which forms the remaining portion of the Central and South American Telegraph Company's cables. This length is composed of shore end, intermediate and deep sea type, and has a total weight of 4,880 tons. Besides this the "Silvertown" carried, when passing Portland on the 4th inst., 1,600 tons of coal.

ELECTRIC LIGHT FOR THE NEW LAW COURTS.—In the House of Commons on Monday Mr. Donaldson-Hudson asked the First Commissioner of Works if he would inform the House whether there was any probability of the system of electric lighting by means of incandescent lamps being tested in the House of Commons during the present Session? In reply, Mr. Shaw Lefevre said he proposed to try the experiment of lighting by means of incandescent lights the New Law Courts, and until he saw the result of those experiments he did not think it would be worth while to make further experiments in that House.

THE TAY AND FORTH CABLES.—Although frequently interrupted by stormy weather, the work of repairing the telegraph cable across the Tay, near Broughty Ferry, has been completed by the "Morna." New pieces have been spliced on to the north and south shore ends of the cable, and a flaw near the centre has been repaired. On Saturday and Monday the "Morna" was engaged in the Firth of Forth picking up and taking on board the old seven-wire cable lying between Granton and Burntisland, which had become inoperative owing to the frequent injuries it had sustained by ships' anchors fouling it.

INSULATORS AND HEAT.—M. Lippmann having made experiments with various insulating materials, such as gum lac, gutta percha, essence of terebinth, petroleum, &c., has ascertained that bodies which act as insulators at an ordinary temperature are of no practical utility beyond a certain temperature. In his experiments he placed the insulating bodies between two plates of platinum in the same circuit as one of his capillary electrometers, and a battery of 1 to 40 cells. At an ordinary temperature the electrometer was not affected, but at higher temperatures, not, however, exceeding 100, the mercury in the electrometer gave evidence of the passage of a current. On being cooled again the bodies became good insulators.

THE METROPOLITAN TELEGRAPH CLERKS.—A meeting of the metropolitan district telegraphists was held on Tuesday night, when great dissatisfaction was expressed at the failure of the scheme as at present made known to redress their grievances. It was pointed out that some clerks had been promoted over the heads of their seniors; and, further, that many clerks with from nine to twelve years' service, whose present salaries are £70 or £75 per annum, had not been benefited at all; and also that others with eighteen years' service had received no increase on their present pay of two guineas a week. It was, however, decided that no steps should be taken for a few days, in order to see whether the authorities contemplate any improvement in the positions of

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those clerks who at present had not derived any advantages from the scheme.

TAMPERING WITH TELEGRAMS.—According to a provincial contemporary the Post Office authorities are at present investigating in Yorkshire some cases of alleged disclosure of information contained in telegrams which should be of importance to the sporting world. They lately came to suspect that telegraph clerks in certain places were being tampered with by betting men, and were selling to them important sporting news. They therefore sent some false intelligence about a race. Certain betting men, to whom it had not been sent, nevertheless acted on the faith of that information, and in consequence lost considerable sums of money. The victims openly told of their losses and the cause of them. Moreover, it is known that secret betting among these comparatively poorly paid clerks is known to be spreading to an alarming extent, and whatever be the result of the present investigation, an order will probably be issued forbidding it absolutely, on penalty of instant dismissal.

ON MICROPHONIC CONTACTS IN VACUO.—In a recent number of the *Zeitschrift für Electricitätslehre* Herr Berliner writes on the above subject. According to him, the change in the thickness and density of the strata of air between the vibrating portions of a microphonic contact causes great changes in its resistance. As the resistance of a very dense carbon is not increased by pressure, he explains the fact that the resistance of a microphonic contact can reach a megohm by the intermediate air strata. To confirm this view, he placed a Blake transmitter in a wooden box, hermetically closed, and capable of being connected with with an air pump. Two metal conductors traversed the sides of the box, and enabled the transmitter to be connected with various instruments. The resistance of the contact was weakened by 1-5th when a vacuum was created. When the microphone with one cell of a battery was placed in the primary circuit of an induction coil, and a telephone in the secondary circuit, the intensity of the sound transmitted was the same when the transmitter was in contact with the air as when it was in a vacuum. An editorial note by our contemporary remarks that the way in which the two carbons are fixed, one on the other, has also an influence on the contact resistance. The resistance of the air by itself should vary, as in the electric arc, inversely to the intensity of the current.

LAST YEAR'S ELECTRICAL PATENTS.—Some idea of the extraordinary activity at present existing in the development of electrical science and the practical application of electricity to various useful and industrial purposes may be gathered from the following statistics compiled by Messrs. J. K. Fahie and Son, of the patent offices, High Holborn, London, and Nassau-street, Dublin:—During the year 1881 it appears that no less than 237 applications for British patents have been recorded in Her Majesty's Patent Office for inventions which may be classed under the heading of electricity. Of this grand total 135 emanate from British applicants, 52 from American citizens, and 50 from residents on the Continent (France, Germany, Belgium, &c.). Classifying the total number of 237 applications under special heads, it appears that 93 specifications have been lodged for improvements in electric arc lamps, 20 for improvements in incandescent electric lamps, 38 for magneto and dynamo machines, 32 for secondary batteries or electric accumulators, 26 for regulating, controlling, and measuring the electric current, 24 for miscellaneous appliances connected with electric lighting, and four for producing power and transmitting motion. Reviewing the names of the applicants for above patents it appears that the celebrated American inventor, Edison, stands highest on the list, having applied for no less than 24 patents for various electrical improvements. Messrs. Swan and Lane Fox each filed seven applications, mostly in connection with incandescent lighting, and M. Faure, of Paris, three for secondary batteries, while Mr. Maxim filed two, and Mr. Brush one for arc lighting apparatus.

AMERICAN INSTITUTE OF MINING ENGINEERS.—On the 2nd instant the annual meeting of this institute was held at Washington. Amongst other papers was one contributed by Mr. N. S. Keith, on the uses to which electricity might be put in mining and metallurgical operations. He thought that mining engineers and metallurgists ought to follow developments in electrical science closely, as it offered many opportunities for improvement. As instances, he mentioned the electrical call-bell and telephone as possessing many obvious means of saving time and labour. Electric lighting by the voltaic arc might be introduced with very satisfactory results, as experience had shown in mines and mills, although it was doubtful whether it would supersede other systems of illumination in the working of narrow veins, as the quantity of light was more than was needed. In the driving of the new Weehawken Tunnel, near New York, there were eleven arc lights on one circuit of two-and-a-half miles in length to illuminate the different open cuts and shafts in the line of the tunnel, and it had been found that more and better work could be done. Mr. Keith briefly described the utilisation of electricity for the transmission of power as employed currently for hoisting coal in an incline in a colliery in the Loire District, France. Passing to the application of electricity in metallurgy, he stated that at Swansea the refining of copper by the electrolytic method had been practised for some years successfully. Black copper plates, containing gold and silver, were made the anode in a sulphate solution, pure copper plates being the cathode. When a current of electricity generated by a dynamo-electric machine was passed through it, the copper in the black copper was dissolved, and a pure metal, selling at a high price for the use of wire for electrical purposes, was deposited on the cathode, the residue of silver and gold being treated in the ordinary way. This process of refining was also in constant use at Hamburg and at London. Mr. Keith stated that he had somewhat modified an analogous process invented by him to treat base lead bullion. Formerly he treated the base bullion directly. He proposed to separate by this electrolytic method the rich zinc-lead-silver alloy obtained in the Parkes zinc desilverising process, almost universally used in America. He then described the Siemens method of melting metals by the aid of electricity, and referred to the storage of electricity, giving details of the Planté and Faure batteries. He stated that he had constructed a battery based on the principle of the Grove gas cell, which depends upon the decomposition of water. He stores up in separate reservoirs the gases generated, and by a peculiar mechanical arrangement, details of which he was unable to publish at present, again utilises them for the generation of a current of electricity. He estimates that it has ten times greater capacity for a given weight than the Faure battery, as the energy required for the decomposition of one pound of water, and, therefore, the current regained, are much greater. In the discussion which followed the reading of the paper Professor Silliman stated that in Connecticut a company was coating on a large scale steel wire for a new form of conductor by the electrolytic process.

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THE ELECTRIC LIGHT AT THE MANSION HOUSE.

A good deal of interest has been excited by the introduction of incandescent lights for interior lighting, and the public mind is anxious to know the result of any experiment in which these lights are used. The work at the Mansion House by Messrs. R. E. Crompton & Co., however, possesses still further interest to electricians, inasmuch as both the arc and incandescent systems are used for interior lighting. It is admitted that the arc system is economical, but there are comparatively few rooms in which such a flow of light would be required or would give any advantage. The incandescent lamp, on the contrary, is the lamp upon which the future of the electric light depends, so far as interior lighting is concerned. The lighting of the Egyptian Hall and the saloon at the Mansion House is by means of six Crompton arc lamps in the Egyptian Hall, and forty-four Swan (incandescent) lamps in the saloon. We show in Fig. 1 an elevation, and in Fig. 2 a plan of the arrangement of the engine and machine in the vaults underneath the Mansion House.

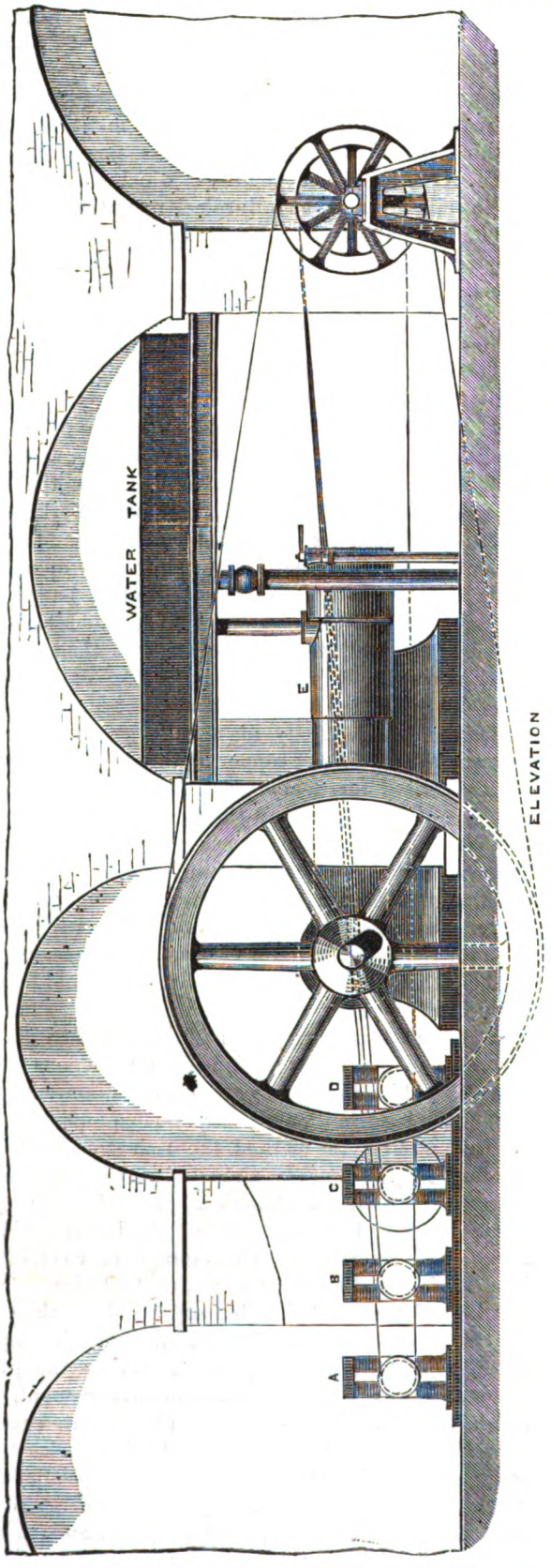

FIG. 1.

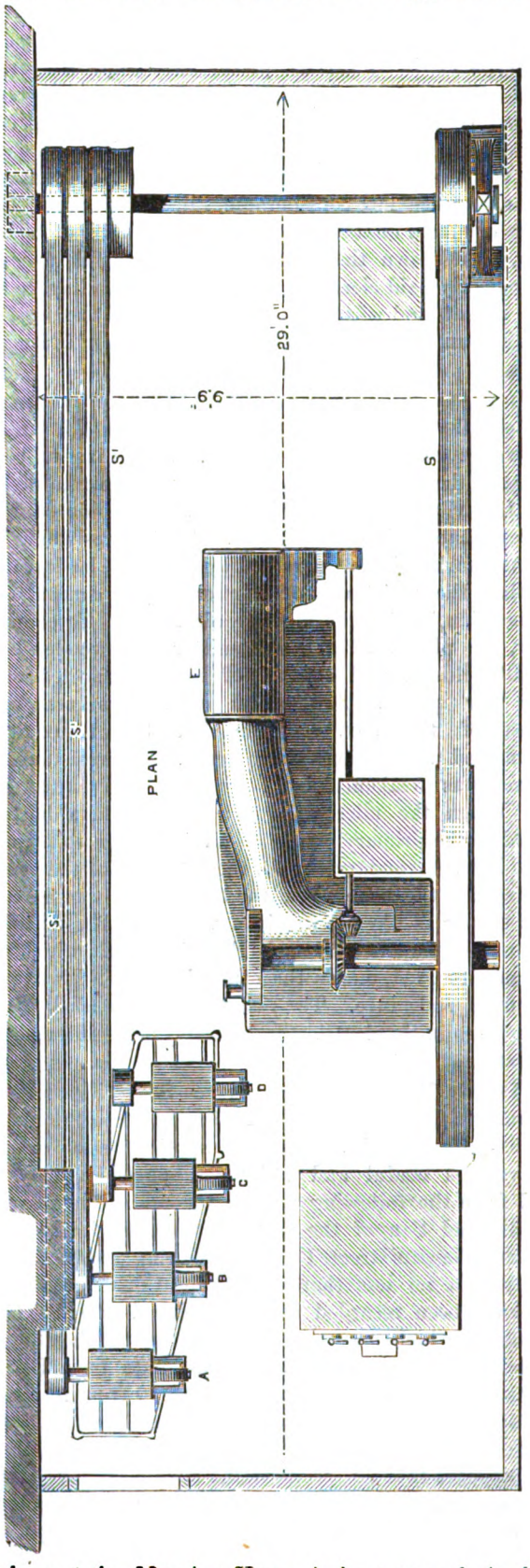

FIG. 2.

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The space at the disposal of Mr. Crompton was very limited, and his motor power was restricted to a gas engine, which has unfortunately more than once failed to work when most needed. The gas engine is of 16 h.p., and is built by Messrs. Crossley, who will no doubt, by careful consideration of the requirements, arrange that a break-down may not again occur. The engine has an excess of power over and above that now required, but it may be that another electric circuit will be introduced, when the extra power will be wanted.

It will be seen that Mr. Crompton uses four dynamo machines, marked respectively A B C D. One of these, D, is a reserve machine, to be used in case of accident, or should another circuit, and, therefore, more current be required. The dynamos are driven by cement jointed bands, S^1 S^1 S^1 from counter-shafting. The band pullies on the counter-shafting are 2ft. 3in. diameter. The engine has an 8ft. fly wheel, carrying band S, and makes 136 revolutions per minute. Strap S goes over a 3ft. pulley on the counter-shaft. The dynamos A and B have 7in. pulleys, C and D 6in.;

VERTICAL DYNAMO MACHINE

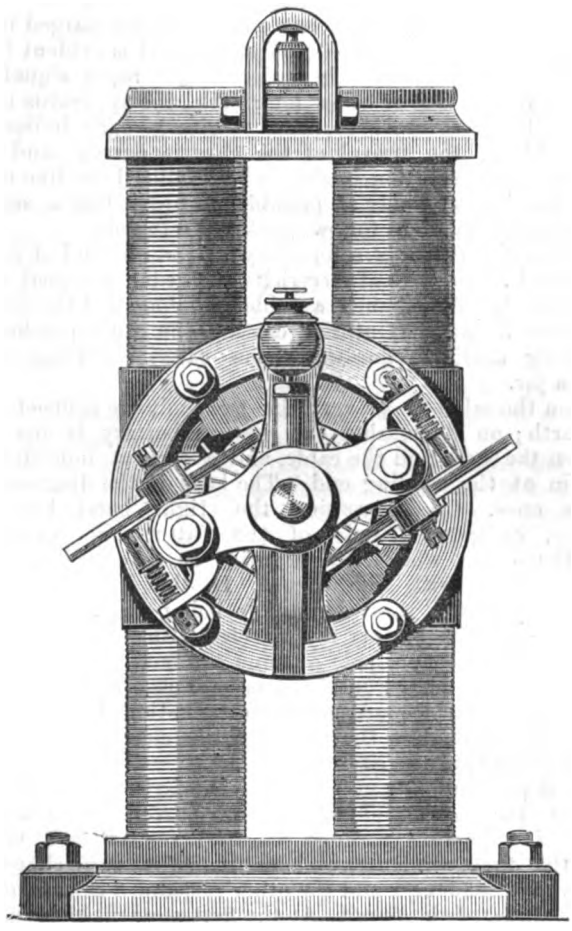

FIG. 3.

a speed is thus obtained for A and B of about 1,296 revolutions, and for C and D of 1,512 revolutions, per minute. The engine is shown at E, with the water tank above head, in one of the arches. As will be seen by the dimensions in the plan, the space occupied by the machinery is 29ft. by 9ft. 9in., and this is partly filled with the pillars. The plan shows that one of these pillars had to be hollowed out to admit a part of the engine. The dynamos are fixed on a planed cast iron bed plate, grooved to take the holding-down bolts and to allow the moving of the machines slightly in order to tighten the straps.

The two dynamos A and B are used to generate the current for the six Crompton arc lamps in the Egyptian Hall, three lamps in each circuit. The dynamos are those known as the Bürgin, and are manufactured by Mr. Crompton. Generally, however, the machines are horizontal, but partly to economise space the machines at the Mansion House are vertical, as shown in Fig. 3. The armature of the Bürgin machine is made up in sections, one section being placed a little in advance of the next, and so on, in order to obtain what we may for the moment term an equable effect, and, revolving at the previously-mentioned great velocity, gives the machinery a high E.M.F. Fig. 4A shows the arrangement of the arc lamp circuits. When the dynamos A and B are revolving 1,600 times per minute, the E.M.F. of the machine is then 300 volts, so that under the conditions holding as above the E.M.F. is about 244 volts.

The resistance of each arc lamp is about 2 ohms, the resistance of the external circuit lamp wires and all is about 8 ohms, that of the machine 3·7 ohms, so that the current through each lamp is about

$$C = \frac{E}{R + 2} = \frac{244}{8 + 3{\cdot}7} = \text{nearly } 21 \text{ amperes.}$$

In the formula C = current; E = electromotive force; R = external resistance, and r = internal resistance.

Machine C supplies the current for the 44 Swan lamps in

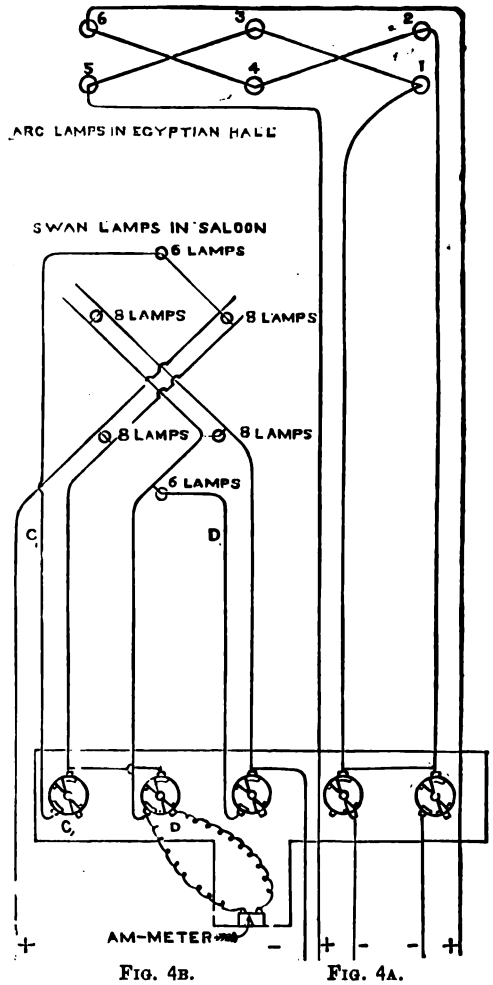

FIG. 4B. FIG. 4A.

the saloon. Owing to the pulsation of the gas engine affecting the steadiness of the light, a fly-wheel of 2ft. diamater has been fixed on this machine with the best results. The lights burn beautifully steady and have given the greatest satisfaction. The Swan lamps are placed on two branch circuits (Fig. 4B) with three chandeliers in each circuit containing 8, 8, and 6 lamps respectively. The lamps are all in single parallel arc, and similar calculations to the above show that the current through each lamp is from 1·3 to 1·5 amperes.

The Swan lamps, as we have said, are in single parallel arc, the groups of lamps being in compound parallel arc. The wires of the two circuits of three groups being led back to switches, can be made into separate circuits if required. This is done by leading a separate return from the lamps to the switches. The switches C D are shown with the circuits disconnected. The internal fittings, which we shall illustrate in another issue, are by Messrs. Wingfield, of London and Birmingham.

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CRYSTAL PALACE EXHIBITION.

Exhibits of the School of Electrical Engineering and of Submarine Telegraphy.

The apparatus exhibited consists of two artificial telegraph cables, devised by Cromwell F. Varley, F.R.S., the one representing the Atlantic telegraph cable, the other a cable working forty times slower, so as to represent the phenomena which would present themselves on a cable of the same dimensions per nautical mile as the Atlantic telegraph, but 13,000 miles in length, long enough to reach from England to Australia.

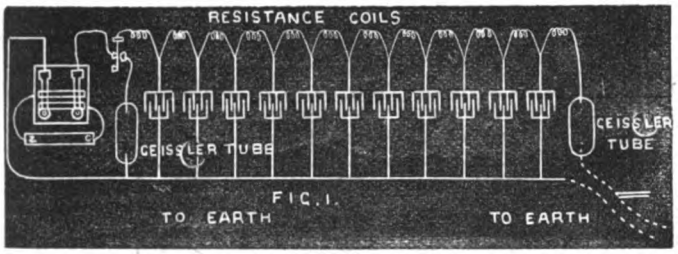

FIG. 1.

Fig. 1 represents the former of these, which consists of 11 coils of fine German silver wire, having together the same resistance as the actual Atlantic cable. The phenomena of electrostatic induction were given to this conductor by attaching to each of the junctions between the coils a large condenser. The second, or slow artificial line, consists of 11 glass tubes, and the apparatus is so constructed that by turning a handle the condensers can be removed simultaneously from the resistance coils and reapplied as often as necessary. A galvanometer is inserted between each of the tubes in the latter circuit.

Electricity, in passing through a cable, begins instantly to appear at the distant end, but in strength too weak to be measured. After the lapse of a certain time it begins rapidly to augment in power, but to reach its maximum strength would require an infinite time, while to reach half its maximum strength would occupy a time of 6 a, this quantity, a, being a definite time dependent upon the dimensions of the cable.

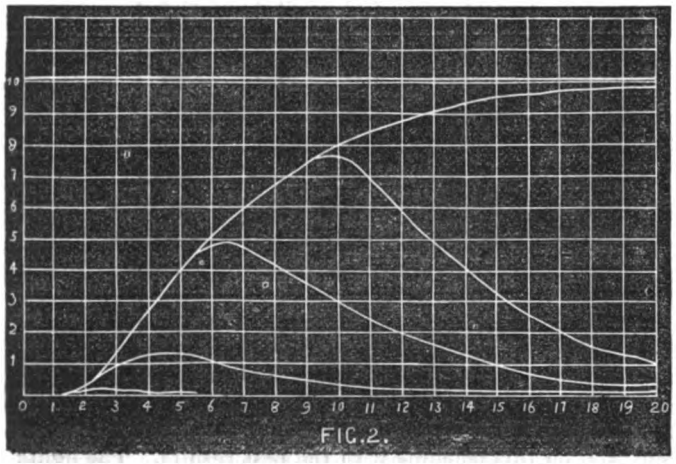

FIG. 2.

In Fig. 2, curve No. 1 represents the strength of the current at the distant end of the cable, after the lapse of periods of time represented by the figures under the diagram, the maximum strength which the battery can produce through the cable being represented by 10. The figures on the horizontal line represent equal periods of time, a. The figures on the vertical line represent the strength of the current. On connecting one end of the cable to a battery whose other pole is to earth no sensible current is visible until after the lapse of the period a, when the current has a strength of a little more than a thousandth part of that which the battery is capable of producing.

When the cable is fully charged the current attains its maximum strength, which is represented in the diagram by the line opposite the vertical figure 10. After the lapse of 4 a, the strength of the current is about one-fourth of this maximum power. After the lapse of 6 a it has a strength equal to half the maximum, and for greater periods of time the strength of the current goes on augmenting if the battery be continually applied, as shown by curve No. 1. But although it approaches to, it never, in strict language, actually attains the absolute maximum strength 10. For instance, after 20 a, the strength of the current is about 98 per cent. of the maximum.

The curves 2 and 3 show the rise and fall of electric currents at the distant end after the cable has been connected to the battery for intervals of time corresponding to 12 a and 6 a; and after such contact with the battery, the cable has been connected to the earth again. This is about as quick as it is possible to signal through a submarine cable with the ordinary Morse instrument. No. 2 represents a "dash," No. 3 a "dot." The little curve 3 represents a signal whose strength is only 1 per cent. of the maximum strength. Such signals are only to be obtained either by the curb-key or the use of condensers at the end of the cable, as explained further on. It will be seen that considerable time must be allowed to elapse after the impulse has been given for a dot or dash before the cable has sufficiently discharged itself to permit of a second intelligible signal. It is evident from the above diagram that in order to get rapid signalling through an Atlantic or other long cable, the apparatus must first of all be very sensitive, so as to give as early indication as possible of the arrival of the electric current, and the moment such indication begins to be produced the line must be discharged as quickly as possible, in order that a second signal may be made to follow quickly afterwards.

A telegraph cable is a long Leyden jar, one end of which is attached to a source of electricity each time a signal is to be produced. When such a cable is submerged the copper conductor forms the interior coating, the gutta percha the insulating medium, the water the exterior coating of a Leyden jar.

When the cable is at rest the two ends are connected to the earth; on depressing the key, a battery is inserted between the earth and the cable, and a current immediately flows in at the sending end. The keys in the diagram are double ones. On depressing the right hand key the positive, or copper, pole of the battery is connected with the cable, while the negative or zinc pole is left in connection with the earth. If the left hand key be depressed, the right hand key being up, the negative or zinc pole of the battery is connected with the cable, while the positive or copper pole remains connected to the earth. The second key shown in Fig. 1 is used as a switch to connect the cable at pleasure either to the battery key or to the Geissler tube, to show the escape of the charge in the cable from both ends of the circuit.

On depressing one of the keys the battery is inserted between the earth and the cable; current immediately flows; after passing through the first resistance it meets with the first condenser; here it finds two channels, namely, the condenser and the other resistance coils forming the remainder of the circuit. At the first moment of time, the condenser being empty, it offers no appreciable opposition to the electric current, which commences charging it, and therefore at the first instant of time nearly the whole of the current is spent in charging the condenser. No sooner, however, has the charging commenced than this charge begins to oppose the further flow of electricity into it; a current then flows through the second coil; its strength is dependent upon the potential for the time being of the charge in the first condenser. Example: Suppose the potential of the battery to be 100 (and its resistance practically *nil*), let the resistance of each coil be 1 at the first moment of time; as the first condenser offers no sensible resistance, there will be a resistance of 1 only in circuit. By Ohm's law the strength or volume of the current is—

$$C = \frac{E}{R} = \frac{100}{1},$$

where C equals the volume of the current, E the potential or E.M.F. of the battery, R the resistance in circuit.

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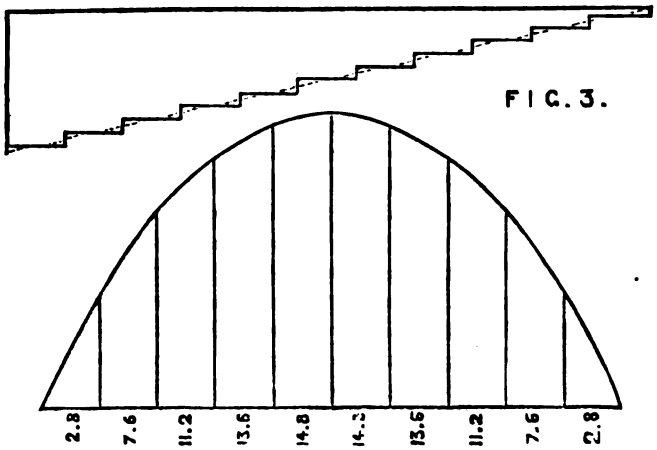
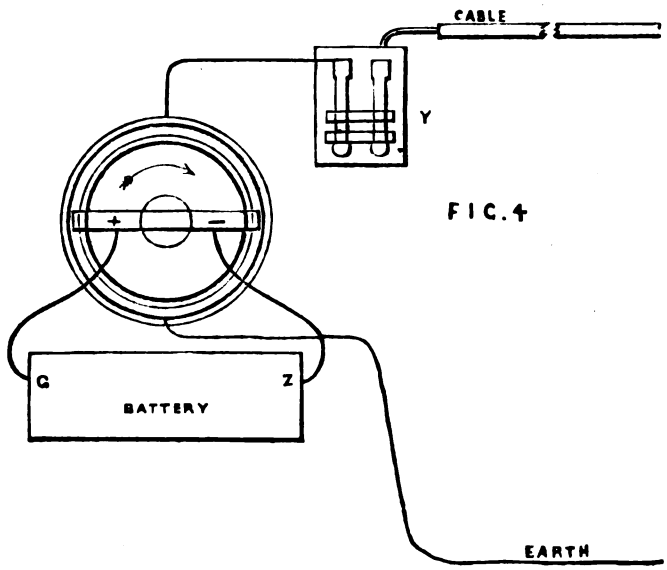
After the lapse of a very short interval of time, the first condenser will have become charged to a potential of 1-100th part that of the battery, viz., 1, at that moment of time, as there will be no sensible charge in the second condenser; the strength of the current in the second resistance coil will be 1-100th part the strength of the current that flowed through the first coil at the first moment of contact with the battery. Thus it will be seen that no appreciable current will be found in any of the other resistance coils until an appreciable charge has reached the condenser immediately preceding it.



With the 10 galvanometers inserted in the long cable at equal distances, it will be seen that, at the first moment of contact with the battery, the current rushing into the cable is vastly greater than it is a few moments afterwards. This is illustrated by the large artificial cable. The 10 galvanometers are placed one above the other. The rays from a lamp of special construction were thrown upon the 10 mirrors, which reflect back the 10 images upon a screen placed at a suitable distance in a vertical line when no current is passing. The galvanometers are all similar.

Let us suppose the first station Gibraltar, the second Malta, the third Suez, the fourth Aden, the fifth Bombay, the sixth Calcutta, the seventh Rangoon, the eighth Singapore, the ninth Java, and the tenth Australia.

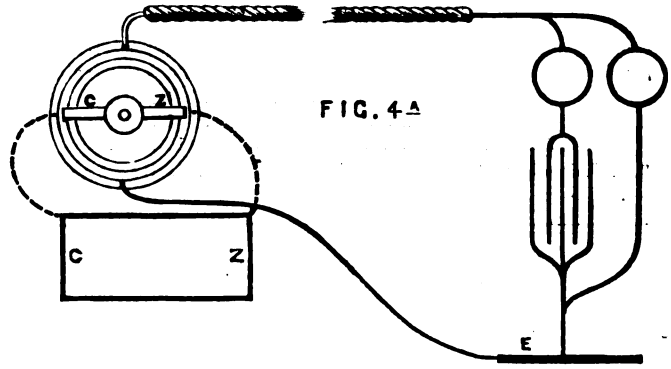


On depressing the key, the instrument placed at the first station almost immediately responds, and when it has reached a certain distance, the second station is seen to move. Later still the current at the first station decreases considerably in strength, owing to that end of the cable becoming charged, and so on, until after the lapse of nearly a minute a powerful current rushes out at the Australian end. Then, if the English end is removed from the battery and put to earth, the Gibraltar spot crosses to the other side, showing a powerful return current—this is followed by Malta's, that of Suez, and Aden, Bombay returning to zero—the current in the cable flowing out at both ends, and leaving Bombay neutral, and when a succession of signals are sent into the cable of five seconds each, these impulses produce waves which can be distinctly traced as far as Aden, where their individuality becomes lost.

In 1853, 1854, and 1856 Cromwell F. Varley invented means for clearing the lines after these impulses.

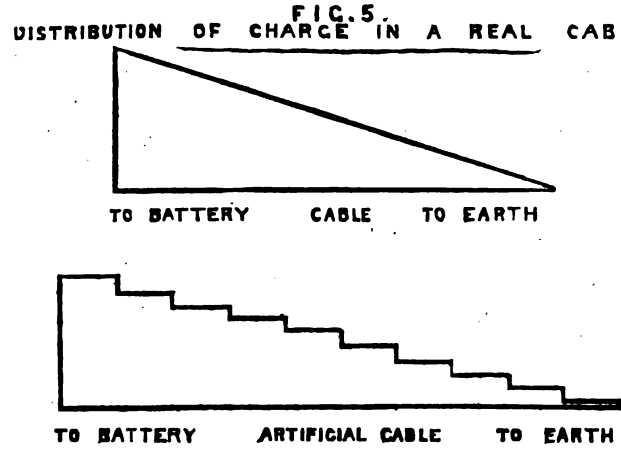
Fig. 3 is a diagram showing the electrostatic retarding value of induction in an insulated conductor of uniform dimensions.

Fig. 4 shows the apparatus constructed by C. F. Varley for imitating the electrical disturbances arising from what



are generally designated magnetic storms or "earth currents." It is now well known that these currents do not change suddenly, like electric signals, but go over gradually from positive to negative, the shortest time occupied being 50 or 60sec. changing from maximum positive to maximum negative, and sometimes the change is spread over an interval varying from 5 to 10 minutes. With the arrangement shown (Fig. 4A), which consists of an annular trough, filled with a solution of sulphate of zinc, having a fly clock rotating a cross bar, from which hang two pieces of amalgamated zinc, connected with the two poles of a battery, as in the figure, no current flows into the cable; but when this cross bar has moved 90 degrees from the position shown, a positive current flows, and on its reaching 180 degrees more the current has changed sign, and reached its maximum negative strength. The method of destroying earth current disturbances, introduced

FIG. 5.



by the same inventor, is also exhibited. Fig. 5 simply shows the distribution of charge in an artificial and a real cable, and this can also be seen in one of the figures in Diagram 3, showing that the actual results obtained are the same in both the artificial and real. In fact, it was from this very apparatus, now exhibited by the School of Telegraphy and Electrical Engineering, that the dimensions of the original Atlantic cables were determined by C. F. Varley.

The school also exhibits one of Sir William Thomson's syphon recorders, working through one of their cables on to another syphon recorder stationed at the stall, and belonging to the Eastern Telegraph Company.

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THE INSURANCE COMPANIES AND ELECTRIC LIGHTING.

A short time ago we gave our opinion very plainly upon the supposed dangers of electric lighting. The consideration of that subject had been provoked by accidents endangering human life from a shock of electricity; but incidentally we touched upon the risk of conflagration through the chance escape of a current powerful enough to ignite combustible material in close proximity to the conductor. This latter phase of the question has now been revived by the action of the insurance companies in relation to the Electrical Exhibition at the Crystal Palace, or in supposed relation to that Exhibition, for we are by no means certain that the electrical portion of it is responsible for what has taken place. We said distinctly on the former occasion to which we have referred that the dangers of electric lighting are not greater than those attending gas lighting, and we emphatically adhere to that opinion. The risks are not greater, and such as they are, they can be guarded against, if anything, more easily than can the risks inseperable from the supply of an explosive gas.

What, then, has caused the insurance companies to double their premiums upon the edifice and contents of the Crystal Palace during the next six months? The additional tax is an exceedingly heavy one, and every one will regret the burden thus imposed upon the proprietors while doing a great service both to science and to the public at large. The rate of insurance will in some instances, we are told, be as high as 70s. per cent., and this in cases which had previously been covered by 30s. or thereabouts. For the edifice alone the extra charge is estimated at some £2,000, a considerable slice, it must be admitted, off the legitimate and well deserved increase of revenue during the show. And this, perhaps, is not all, for it is rumoured that the permanent exhibitors may require the Palace Company to pay the extra premiums to which they are rendered liable through no action of their own.

All this is very unfortunate; but, as touching the electric light, it has no very special significance. Some of our contemporaries have at once jumped to the conclusion that the insurance companies have taken alarm, and that henceforward the electric light is going to be heavily handicapped in its race with gas. One of these alarmists petulantly exclaims that the insurance companies have done this wilfully foolish thing "all because the Palace is now rendered safer by reason of the electric light than it was before." This may be meant for sarcasm, but to us it sounds childish, and reminds one of the pharasaical young man from the north, who, when asked by a candid friend why he was so universally detested, replied that it was because he was so unco gude. And, doubtless, he was an uncommonly good young man—all young men from that quarter themselves assure us of the fact; but the wicked southerners perhaps do not believe him, and in any case, if he is disliked, it is certainly not because of his goodness. We may depend upon it the insurance companies have acted advisedly, though, possibly, mistakenly; the explanation being that they do not believe in the increased security of the Palace in its present circumstances.

And this we conceive may very well be the case without the electric light being incriminated at all. There are a number of strange steam engines and gas engines now on the premises or immediately adjoining; they are erected sometimes in wooden sheds, and the arrangements all through are necessarily of a temporary character. If the introduction of machinery driven by fire and steam is usually attended with extra risk, from the insurance office point of view, we can see nothing surprising in the same view being taken of it when a structure like the Crystal Palace, with its valuable contents, are concerned. We are, at all events, not in a hurry to assume that these newly-awakened apprehensions of fire are due solely or even largely to the presence of electric lighting on a considerable scale.

The scale, however, is not only considerable, it is varied, and, moreover, mixed up in such a way as is never likely to be adopted in practical application to either useful or ornamental purposes except at an exhibition. It would be discreditable to electrical engineering were any serious accident to happen; but, all the conditions taken into account, accident, if excusable anywhere, would be excusable at the Palace. In the first place, the installation is not a permanent one; and, in the next, there are systems on view in the interior which were obviously designed for outdoor use. Many other practical considerations will suggest themselves at once to every man of experience, and we need not enlarge upon them here; they have probably weighed with the advisers of the insurance offices in recommending them to cover the possible chances of disaster.

In the experimental stages of a new career like that of electric lighting it must not be wondered at that timorous people are rendered more timid and cautious people more wary. It is for the electrical engineer to steer his course accordingly, and on his part to be as careful and conscientious in his work as if he himself were the insurer. With wires duly protected for arc lights, and guarded by fusible bridges for incandescent lights, the risk of conflagration is absolutely *nil*. But this must be proved in practice—proved, we mean, to the satisfaction of non-professional observers like insurance companies, and of the professional looker-on, who

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undertakes the grave responsibility of advising them. That it will be so proved, and in a reasonable time, we confidently predict. Meantime, we are not in the least disconcerted by anything the insurance companies may do. They know their own interests too well to discourage a mode of illumination having any claim to superiority in point of safety for the property which they have insured. What we have to do is to make this superiority quite manifest by careful engineering and good workmanship; without these gas lighting would have broken down, and with these electric lighting will assuredly succeed.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

XI.

Electromotive Force.

The difference of pressure between any two points of a gas or other fluid is a measure of the force urging the fluid to flow from one point to the other. *The difference of pressure may be measured by the work required to convey a unit volume of the fluid from one point to the other.* Consider an elastic bag full of air, and let the pressure of the air outside the bag be p and inside p'. To pump a small additional volume, $d\,v$, of air or anything into the bag requires work $(p' - p)\,d\,v$ to be done; hence, to pump unit volume in requires work $p' - p$—that is, work numerically equal to the difference of pressure. Only the unit volume must be small enough compared with the bag not to raise the pressure appreciably by its addition.

Next consider two points under water, one where the pressure is p, the other where it is p'; and let their depths beneath the surface be h and h'. Carry a small weightless volume, u, from one to the other. The force acting on it is always $u\,g\,\rho$, and therefore the work done is $u\,g\,\rho\,(h - h')$; so, if the volume had been unity, the work done would be $g\,\rho\,h - g\,\rho\,h'$—that is, $p - p'$.

These are very simple illustrations of a general principle.

The measure of the difference of magnetic potential $V - V'$ between two points is the work required to convey a unit pole against the magnetic forces from one point to the other. If the pole is of strength m, the work done, or the gain of potential energy, is $m\,(V - V')$.

$V - V'$ may be called the magneto-motive force between the two points.

The same with electricity. To drive Q units of electricity against the electrical force, from a place where the potential is V to a place where the potential is V', requires work $Q\,(V - V')$. The work will be done *by* the electricity if it is allowed to go *with* the electrical force; and $V - V'$, or the loss of potential energy per unit of electricity travelling down from V to V', is called the electromotive force between the two points.*

Call this E. Then E Q is the work done by electrical forces when Q units are driven by the electromotive force E.

By putting $V' = 0$, we see that the whole energy of a charge, at a place where the potential is V (independently of the charge itself), is Q V.

If the potential is due to the charge itself solely, it is easy to see that its energy is only $\frac{1}{2}$ Q V.

Now let electricity flow as a conduction current along a wire, of which one end is maintained by a battery at the potential V, the other at the potential V', and let the current γ flow for time t, so that Q, the number of units transmitted, is $\gamma\,t$; then this is a case of $\gamma\,t$ units flowing from a potential V to a potential V', and the work done is $\gamma\,t\,(V - V')$, or $E\,\gamma\,t$.

$E\,\gamma$ is the work done by the current in unit time, or the "power" of the current.* If no other form of energy is the result of this work, an amount of heat equivalent to it must appear in the wire, viz.,

$$\frac{E\,\gamma\,t}{J} \text{ thermal units.}$$

The "power" of the current in the wire is thus $(V - V')\,\gamma$, or $E\,\gamma$ ergs per second, the erg being the C.-G.-S. unit of work, and meaning a centimetre-dyne.

We can express it in horse-power if we like:

$$1 \text{ h.-p.} = 33000 \text{ foot pounds per minute}$$
$$= \frac{33000 \times 32{\cdot}18}{60} \text{ absolute British units of work per second.}$$

But 1 foot = 30·48 centimetres, and a pound = 453·6 grammes.

$$\text{Therefore 1 h.-p.} = 33000 \times 30{\cdot}4 \times 453 \text{ centimetre-grammes per minute}$$
$$= \frac{33000 \times 30{\cdot}48 \times 453{\cdot}6 \times 981}{60} \text{ absolute C.-G.-S. units per second}$$
$$= 746 \times 10^7 \text{ ergs per second.}$$

So the horse-power of a current of strength γ driven by an E.M.F. E is

$$\frac{E\,\gamma}{7{,}460{,}000{,}000},$$

if E and γ are expressed in absolute measure.

The dimensions of E.M.F. on the electro-magnetic system are easily found to be a velocity multiplied by a square root of a force or $\frac{(\text{mass})^{\frac{1}{2}}\,(\text{length})^{\frac{3}{2}}}{(\text{time})^2}$.

The unit of E.M.F. is that which does an erg of work while it drives a unit of electricity.

The heat value of an erg is $\frac{1}{J} = \frac{1}{42 + 10^6}$ thermal units;† so the unit current (which is large, 10 webers, see Art. X.) would only generate in a conductor a unit of heat in 42×10^6 seconds—that is, in about five days—if driven through the conductor by unit E.M.F. The unit E.M.F. is accordingly very small, only about the 100,000,000th of a Daniell cell.

The unit employed by practical electricians to be of more convenient size is 10^8 of these absolute C.-G.-S. units, and is known as a volt.

Express the E.M.F. in volts and the current in webers and we shall have the number expressing the product $E\,\gamma$ only $\frac{1}{10^7}$ as large as before. That is, *the horse-power of a current is its strength in webers multiplied by its E.M.F. in volts and divided by* 746.

Measure of Electromotive Force.

To measure a difference of potential in absolute electromagnetic measure is no easy matter. It can be measured electrostatically, if large enough, by Sir William Thomson's absolute electrometer. In this instrument the force, F, with which a trap-door of area A in one plate is attracted by a parallel plate facing it at a distance z, is the thing observed; and it is easy to show that the difference of potential between the two plates is then

$$z\sqrt{\frac{8\,\pi\,F}{A}}.$$

But to get observable indications with one of these instruments you must have an electromotive force capable of producing sparks, such as is obtained in Leyden jars.

Hence it is hopeless to attempt to measure the difference of potential between the ends of an ordinary wire or resistance coil by such an instrument.

Professor Minchin has, however, modified it by arranging the parallel plates vertically, and making the trap-door a

* The force in every position is $\frac{d\,V}{d\,x}$ per unit of charge, so the work done per unit is $\int \frac{d\,V}{d\,x}\,d\,x$—that is, V − V',

* "Power" means rate of doing work, or the work done per second.

† A unit of heat can raise a gramme of cold water one degree centigrade.

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very light aluminium disc suspended by long threads; the two plates also being fixed exceedingly close together.

The most minute motion of the trap-door can be observed by a microscope; and the pair of plates can be tilted about a horizontal axis, through a small measured angle sufficient to counteract the attracting force and bring the disc back again, by means of a fine micrometer screw at some distance from the axis of rotation. This instrument, which the inventor calls his "Absolute Sine," is sufficiently delicate to indicate the electromotive force of one or two Daniells, and it can be applied by measure an ordinary difference of potential in absolute electrostatic measure.

To reduce this to electro-magnetic measure we must multiply by the velocity of light, viz., 3×10^{10} centimetres per second; and to bring it to volts we must divide by 10^8; hence, the difference of potential indicated by a tilting of the plate through the angle θ is, if the aluminium disc weighs w grammes,

$$300\, z \sqrt{\frac{8\,\pi\, w\, g \sin\theta}{A}} \text{ volts.}$$

CORRESPONDENCE.

THE POSTAL TELEGRAPH DEPARTMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A "T. S. Operator," writing in your issue of June 4, 1881, predicts that if the scheme of Mr. Fawcett, which had not at that time been promulgated, did not recognise technical knowledge and ability on the part of the operating staff, the minority who were possessed of such acquirements would either soon lose the little they had learnt or else transfer their services to those who would better appreciate those qualifications. This prediction is not only likely to be verified as regards the clerks in the London office, but will also, and probably to a greater extent, be confirmed in the case of the provincial offices, where the scheme, in addition to ignoring technical ability, deals less liberally with them in other respects than with their more fortunate brethren in London. The result which this lack of official recognition and encouragement to the study of scientific telegraphy has already had, and is likely to permanently have, upon those who have hitherto taken an intelligent interest in this subject may be judged of by its effect upon the technically-inclined portion of the staff at Newcastle-on-Tyne, "a station . . . . always famed for the excellence of its staff" (*vide* your article, September 10th, 1881).

In June, 1880, the secretary of the Post Office issued a circular, which from its tenour appeared to be based upon the recommendations of the Select Parliamentary Committee (1876), which were strongly cast in favour of a technical knowledge forming part of every operator's training. This circular distinctly stated that future promotion in the service would depend largely upon technical knowledge and efficiency. Subsequently the clerks in many of the large offices were subjected to a technical examination at the hands of a technical officer. The result of this official action was generally to greatly increase the desire amongst the staff to acquire that scientific knowledge of telegraphy which was, apparently, considered so advantageous to the service. For some time prior to the issue of that document an electrical class, composed of telegraph clerks, had been in existence at Newcastle-on-Tyne. This was ultimately supplemented by the formation of a telegraphy class under the auspices of the City and Guilds of London Institute. The class at one time comprised no fewer than 46 telegraph students, many of whom passed highly successful examinations. It is now found that under the so-called amalgamation scheme technical matters are entirely ignored, and it is a fact that many instances have recently occurred where the study of technical science has been actually disapproved of by postal superiors as being quite unnecessary, and beyond the scope of an operator's duty. It is to be feared that too much emphasis has been placed upon the question of subordinating all the telegraph *employés*, including those who were in the late companies' services, to the Post Office officials; for in every case the superintendents at the head of the telegraph branch—long services notwithstanding—rank below the chief clerks in the Post office, thus, in many cases, reversing the positions formerly occupied by these functionaries, and that generally the postal officials have received the lion's share of the superior appointments. Yet it was recently stated by the Postmaster-General in the House of Commons that these appointments were made with due regard to ability and length of service. The statement is not easily reconciled with the facts.

The sense of injustice, disappointment, and discouragement amongst the clerks at this office since the advent of Mr. Fawcett's scheme has been so keen that the Telegraphy Class has utterly collapsed, and scarcely one of its late members is now to be found who has not directed his attention and energies into other and more appreciative channels.

Is not such a state of affairs alike prejudicial to the interests of the public and the service?

The public are asking and the Associated Chambers of Commerce are petitioning for greater telegraphic facilities and reduced charges; but how these requests are to be complied with is not quite clear.

In these days of high speed Wheatstone, Duplex, and Quadruplex telegraphy no doubt the existing wires are capable of an increased capacity if only qualified technical men were employed in their manipulation.

The prospects, however, in this direction will remain anything but hopeful so long as the present attitude of the authorities is maintained.

The waning interest in technical matters displayed by the staff will shortly tell its tale, and if no inducements are held out to the operators to interest themselves in the scientific and technical details of the complicated instruments placed under their charge, they must inevitably deteriorate, and the knowledge that has already been acquired by the few will be lost.

Referring to the working of the telegraph system in India, the Parliamentary Committee in the report previously alluded to states that "much advantage has been found by educating both the officers and station masters in the science of telegraphy. This superior instruction has not only produced increased efficiency, but also large economies in working." In the face of this overwhelming argument in favour of the benefits of technical instruction, the retrograde step which the officials have taken in the matter is perfectly incomprehensible, and is only susceptible of one explanation, viz., that of being afraid to recognise it, lest by doing so it should lead to the irresitible conclusion that such knowledge should be suitably remunerated, and, from a Post Office point of view, this in turn might lead to that much dreaded result, the partial subordination of the Post Office to the Telegraph Service.—Yours, &c.,

TECHNOLOGICAL.

Newcastle-on-Tyne, March 10, 1882.

[We should be glad to see a copy of the circular to which our correspondent refers.—ED. *E.*]

PILE DRIVING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the present time any successful application or transmission of power by means of electricity cannot fail to interest your readers. On Thursday last I visited Hatfield Park to inspect a coffer dam made across the river Lea, the piles to support which were driven by the power of a water-wheel situated at a distance, which power was transmitted by two dynamo machines and a couple of wires to gearing connected with a pile-driver of ordinary construction. These were erected on a barge floating in the river. The machinery, although rather roughly constructed by the *employés* on the estate, worked very well, lifting with ease and regularity a dolly weighing about 4cwt., which left little doubt that, with a few improvements, piles of the largest size would be driven by the same means successfully.

Such an adaptation may prove of much value in certain situations. Great merit is due to the energetic clerk of works, Mr. Shillito, who has so successfully arranged and carried

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out the scheme. The Marquis of Salisbury, who takes a lively interest in electric lighting, as well as in every scientific or mechanical improvement presented to his notice, has, with the assistance of Mr. Shillito, succeeded in lighting by means of the same water-wheel the principal rooms and corridors of the old mansion at Hatfield. For this purpose the incandescent lamp is used, and the dynamo-machine is fixed about a mile and a quarter from the house. I found many improvements in details worthy the notice of those interested in electric lighting.—Yours, &c., J. W. TURNER.

St. Albans Ironworks, St. Albans, Feb. 13, 1882.

THE STORAGE OF ENERGY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a stickler for accurate terminology, more especially from the point of view of mechanical dynamics, I was glad to read at p. 265 of your last issue the observations of Professor Ayrton anent that unscientific solecism "storage of force." But is not the expression "storage of power" equally objectionable? Professor Ayrton appears to employ the terms "power" and "work" as synonyms, but (using his own symbols) it is the latter only that is measured by P F; the former, except in its conversational sense, is always $\frac{P F}{time}$. A double amount of storage signifies necessarily a double quantity of *energy* stored up; but it no more involves the idea of a double *power* than it does that of a double *force*.—Yours, &c., DESMOND G. FITZGERALD.

A COMPARISON AND LAMENTATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You may think it worth while to print the following from a lamentation by Frank Ives Scudamore, which issues at the same time as the announcement of the promotion of his *protegé*. Post Office telegraphy has, I fear, jumped out of the frying pan into the fire:—

TWELVE YEARS AGO.

Fifth February, 1870. *Transfer of the telegraphs to the Government.*

Twelve years ago! When life was strong
And pulses quick; when hopes were high,
Nimbly the moments tripped along,
Swiftly the hours and days ran by.
For, though no day from toils was free,
Nor any night was free from cares,
The toils and cares possessed for me,
Charms such as leisure never wears;
And told me still, from day to day,
As all too fast the seasons flew,
How flaws, how blunders passed away,
And order from disorder grew.

Fifth February, 1882. *In a very bad hotel at Philippopolis.*

Now, in this semi-savage town,
And more than semi-savage inn,
Listless I watch the sun go down,
Sleepless I watch the dawn begin.
Inveterate habit makes me toil
In scenes with no attraction fraught,
Merely to heal a silly broil
Between the Province and the Porte.
But no bright project stirs my pride,
No ardent comrades cheer me on;
The seas, the years, the Fates divide
My lot from toils and pleasures gone.

Is it not almost past belief that twelve years have elapsed, and that not even sixpenny telegrams, or the registration of telegrams, which previously were both existing, have either been adopted or suggested by the Post Office Telegraphists Mutual Admiration Association?—Yours, &c.,

RICHARD HERRING.

27, St. Mary's-road, Canonbury, N., March 10, 1882.

ELECTRIC SEARCH LIGHTS FOR STEAMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From time to time I have noticed in your columns that various steamers, more particularly the large Atlantic and Australian liners, have been fitted with both arc and incandescent lights. I have also from time to time noticed that such steamers collide, either with smaller craft or each other, with detrimental consequences to everybody concerned, particularly the smaller craft and those on board. I opine that it would not be a difficult matter to have an electric search light, with a powerful lens, fixed on board our passenger steamers at the cross-trees, wherewith they might feel their way on dark nights. There should not then be much difficulty in keeping out of the way of other vessels or the coast even in foggy weather.

Possibly this has already been done in a few isolated cases. But is it not worth the while of the large shipping companies to spend a few pounds in the apparatus necessary for these search lights, and to save the occasional thousands which they now and then lose by the sinking of a large steamer, to say nothing of the additional safety guaranteed to passengers?

Apologising for appropriating what has probably been the thought of very many besides myself, I am, yours, &c.,

CAUTION.

TECHNICAL TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although the above subject has been considered sufficiently important to be included in the programme of the City and Guilds of London Institute, comparatively few classes appear to have been formed upon it.

Now, the recent improvements in telegraphy have been attended by the introduction of apparatus of a very complicated character, rendering it highly desirable—if not absolutely necessary—that operators should have an accurate knowledge of the phenomena with which they have to deal. Therefore, it seems to me the time has fully arrived when the pursuit of this subject should be directly encouraged by the Post Office authorities. I believe something to this effect was recommended by the Playfair Commission.

Thanking you for inserting this, and trusting through your courtesy to hear the opinion of others interested in the subject,—I am, &c., TOTUM.

WIRE-COVERING MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you kindly inform me through your columns if there is any machine in use for covering copper wire with silk or cotton, &c., used by persons thus employed, as I wish to erect one myself?—Yours, &c., A. E. I.

THE ELECTRICAL RESISTANCE OF CARBON UNDER PRESSURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly alter the words "stress producing it" (in the third line of the second column of p. 264 of your last issue) into "strain produced?"—Yours, &c.,

HERBERT TOMLINSON.

THE ACTION OF THE GRAMME MACHINE.

Recent experiments of the Count du Moncel tend to throw fresh light on the action of the Gramme machine. Taking a straight bar magnet he fixes before it a bobbin of wire with the plane of its convolutions parallel to the axis of the bar, as is the case with the bobbin in a Gramme ring as it passes the inducing pole. Then, on inserting a rod of soft iron into the hollow of the coil he obtained a current, which, measured on a galvanometer, gave a deflection of 20°. On pushing the rod still further in and through the coil this deflection rose to 60° and 70°, the latter result being obtained by pushing the rod through the coil at one stroke. Reversing the direction of the movement reversed the direction of the current.

These effects are not the same as those obtained by shifting a bobbin along the line of the inducing magnet. For if a rod of soft iron be placed in front of a magnet so as to become itself a magnet, and a bobbin be moved from the neutral line of the rod towards the inducing pole, a direct current will be set up in the bobbin; whilst its displacement in the same direction from the other end of the rod to its neutral line, will set up an inverse current in the bobbin; so that if the bobbin be moved at one stroke from the farther end of the rod towards the inducing pole the two induced currents will annul each other, and a feeble current, due to the direct induction of the inductor on the bobbin, will result. But in the preceding experiments the maximum effect was got by such a movement.

It is certain that if the two effects were the same, no current should be obtained in the first experiment; for the part of the

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magnetic core which reacts on the wire of the helix is always polarised in the same manner, and as it is always the same mass of iron which excites the inducting magnet, it ought not by virtue of its movement to change the conditions of excitation. In M. du Moncel's opinion the effect can, therefore, only be attributed to the inversion of the polarities of the different magnetic molecules of the rod, which by the movements made by them in the successive changes of their conditions of reciprocal equilibrium give place to corresponding manifestations of induction.

In fact, in the first position of the iron stem in the first experiment the lines of magnetic force are in the plane of the spires of the helix, and, consequently, none of these lines cut the lines. But as soon as the stem is displaced the curved lines of force which correspond to the neutral part of the bar present themselves before the helix, and as at this moment they straighten themselves suddenly they produce an effect like that caused by suddenly shifting the bobbin from a point near the neutral line to the corresponding position at one of the poles of the bar.

M. du Moncel concludes that the currents resulting from the displacement of a bobbin on a stem of iron across a fixed magnetic field are not of the same nature as the currents resulting from the displacement (in a fixed magnetic field) of that stem of iron reacting directly on the bobbin. In the first case the currents provoked by each half of the magnetised stem are in the contrary direction, whilst they are always in the same direction in the other case, and then intensity increases with the displacement, whilst they become almost *nil* in the first case for the complete movement of the bobbin from one end to the other of the rod.

It follows that if we could actually construct a Gramme machine having its induced helices fixed to the inducting poles, whilst the iron ring or core revolved through them, we should have currents almost as energetic as those from the other inductive action, and which would be due to polar inversion, but would require for their collection the same arrangement as in the Gramme machine, for the effects produced at the two opposite extremities of the ring, in the axis of the inductor (even if there were only a single inducing pole), would be in the contrary direction. Such a machine cannot, however, be realised; but as its elements exist in the ordinary Gramme machine, since each bobbin which passes before the inductor is influenced not only by the effect of its movement in the magnetic field of that inductor, but even by the inversion of the magnetic polarities of the part of the iron core that it encounters and by its successive removal from or approachment to the double neutral line of the system, it follows that the Gramme machine comprises in itself three sorts of induction, which are produced in the same direction, as the lines of mangetic force demonstrate.

When the polar inversion currents are excited with an induction bobbin placed in the plane of the neutral line of the inductor, and thus the movement of the iron rod is effected parallel to the axis of the magnet, the effects are very strong but peculiar. If one of the extremities of this stem is thrust into the bobbin, and as the other corresponds to the south pole of the magnet, for example, the movement of the stem, effected whilst the part issuing from the bobbin is of the same length as the part not yet entered, it will give place to an inverse current of 90°, to which will succeed a direct current of almost equal intensity, when the stem of iron is pushed, and when the experiment is repeated from the opposite side. In giving to the iron stem an inverse movement, there is obtained at the first movement a current of 90°, to which succeeds a direct current of almost equal value when the stem is completely thrust through. But if the movement be effected at a single stroke, we obtain an inverse current of 12°, whatever be the direction of the stem. This current is only differential. These effects are easily understood when it is remembered that in the first movements executed from one side to the other of the bobbin we cut the induced helix by curved lines of force from the neutral region of the stem magnetised by influence, and that, in the second movements, these lines cease to cut the bobbin to be replaced by the normal polar lines, which find themselves parallel to the spires of the helix, and, as the polarities of the stem are more accentuated in its extreme position than in its medial position, the first currents are stronger than the second.

These currents of polar inversion are not the only ones which can be obtained from magnetic bodies outside the ordinary effects of induction. Professor Hughes has shown that they can be developed by torsion, compression, or stretching, and M. Ader has founded upon these experiments a telephonic transmitter without a battery.

Electric Light for Lynn (America).—The *Engineering News* of New York states that the Fuller Electric Light Company have offered to light the town of Lynn, Mass., with 100 street lamps from sundown to midnight every night in the year for 50 cents per light.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The members of this society met on the evening of the 9th instant, at the Institution of Civil Engineers, to hear an address by Drs. W. H. Stone and W. J. Kilner, on Measurement in the Medical Application of Electricity. Dr. Stone was the chief spokesman, Dr. Kilner, who followed him, merely describing the character and object of some of the appliances exhibited. After stating that it was at the suggestion of the president of the society that he had ventured to bring this subject before it, Dr. Stone expressed a hope that on some future occasion when their investigations had proceeded further than they had done at present the results might be more interesting to the society. What was wanted now was help from such a quarter as that which he was now addressing, help in the form of exact scientific information, which the medical profession itself was unable to supply. Not the physician, not even the physiologist, but the physicist was wanted at this stage of the inquiry. The physician and the medical practitioner were peculiarly ill fitted for the study of exact measurements, the mastery of which required a different training, and, indeed, a different class of mind altogether. Dr. Stone dwelt for some little time upon the subject of popular delusions with regard to curative electricity and magnetism, and read an extract from a recent number of the *Electrical Review* in which the writer stated that he was the first, in the year 1865, to apply magnetism to therapeutical purposes, and set forth what purported to be the physiological effects of the various currents upon the human body. Every sentence of this utterance, which was now the language very generally met with, contained a gross fallacy; and yet the objects they were intended to promote were evidently much believed in and sought after. One advertisement emanating from the professors of this curious art offered the curative application of electricity to a horse or a cow for the sum of 5s.; the charge for a man was 2s. 6d., whilst for the lowlier class of animals 1s. was sufficient. Now, objectionable and misleading as these pretences were, there was undoubtedly some reality in the phenomena to which they refer. It was, therefore, boldly being attempted to ascertain what these phenomena really were. They were very obscure, and the key to them had yet to be found. The gathering of electricians at Paris had resulted in a report on this subject; but it was of a very inadequate and even inaccurate character. Briefly dismissing the fact that both in vegetable and animal physiology electrical currents were discoverable, as having no bearing on the present inquiry, Dr. Stone went on to explain the several systems of electrification commonly in use. That of induced current had had most attention paid to it; but in his opinion it was not the most efficient. A current from a battery was used by himself and Dr. Kilner, and this, caused to intermit by the interposition of a metronomic make and break, was a very handy mode of applying it. Some figures were then given showing the very high resistance which the human body offered to the current, being as high as 6,000 ohms from hand to hand, and 1,500 ohms from the neck to the base of the spinal cord. The conductivity of the constituents of the body varied very much; and it was a notable fact, telling rather against than for the popular theory, that the nerve tissues were far worse conductors than were muscle or cartilage. These, again, varied in their conductivity by reason of the weather, the state of the skin, personal idiosyncracy, and the condition of health. As illustrating this latter point in a subject recently experimented upon, where one leg was paralysed, there was a difference of some 350 ohms between it and the sound leg. As to the strength of current which patients could bear, the difference was very striking, one case then under treatment in the hospital bearing as much as 50 milliwebers of current, whilst the average bearable current was not more than 30 or 40. With regard to the value of such treatment, it was premature as yet to speak with positiveness, but he mentioned that one or two cases of diabetes had been dealt with in this manner and with some apparently encouraging results. One practical recommendation he could make with perfect confidence, namely, that the poles—that is to say the extremities of the conductors applied to the body, should be as large as possible. The lecturer then described the various attempts that had been made to measure the current actually passing, their desire being to know exactly what amount of work they were doing on the patient, and concluded by inviting the members of the society to aid them in the task they had taken in hand.

Mr. W. H. Preece congratulated the society and the medical profession alike on the lecture they had just listened to, for it was a common experience that whenever investigation discovered its need of exact measurements that moment was the starting point for practical discovery. He assured both Dr. Stone and

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Dr. Kilner that the laboratories and the experience of every electrician belonging to the society would be freely and ungrudgingly at their service. Touching the statement in the *Electrical Review*, he quoted from a little work bearing date 1759, and entitled "Electricity Made Plain and Easy: By a Lover of Mankind," from which it was evident that a century earlier than the boastful claim of 1865 the application of electricity to curative purposes had been suggested, and this by no less a person than John Wesley.

Dr. STEVENS, who followed, mentioned a far more ancient example in the Chinese pharmacopœia, where "pulverised loadstone" was prescribed as having great medicinal virtue.

The discussion was continued by several gentlemen interested in the sale of electro and magneto medical appliances (amongst whom was the writer of the letter above referred to), but whose names did not transpire, and after a brief reply from Dr. Stone, to whom and his coadjutor the usual thanks were voted, the meeting terminated.

ELECTRICITY AND GAS *VERSUS* SMOKE.*

(*Continued from p.* 236.)

So far I have spoken only of gas as a heating agent, but will not electricity have any function in this direction? Well, not apparently at present on any large scale. Any electrical warming apparatus would, as far as we yet know, be incomparably more extravagant than combustion. If you want economical *heat* you can't do better than burn fuel. You can do much better, however, if you want *light*.

But certainly a coil of stout wire, through which more or less of the lighting current could be shunted as occasion required, to keep the air of a room or of a house at a gentle warmth, combined with a coil of platinum wire in every room to warm the walls by radiation, and to give a satisfactory appearance—this would be a most luxurious heating arrangement. And I think it not improbable that in certain cases where cost is of no moment some such arrangement may be employed. I incline to think, also, that to do all the heating by open fires—*i.e.* by radiation—is unnecessary extravagance; and that more comfort, as well as more economy, would be obtained by a *combination* of the air-warming and radiation methods, even when fuel is employed. But I must pass on now to the question of the future production and distribution of power.

In the lighting part of my subject electricity had it all its own way.

In the heating part gas.

In the power part they divide the honours between them.

Our present power is on land, with trifling exceptions, all done by the steam engine. At sea the wind does, I suppose, about half, and the steamers the other half.

Now, it has been known for a long time that a steam engine, beautiful and wonderful though it is,—and I for one have a great affection for it, and always had,—is, it cannot be denied, also frightfully wasteful. Considered as an instrument for extracting the energy out of coal, the very best large condensing Cornish engine wastes 90 per cent. of it—wastes it inevitably and irretrievably, not only from accidental loss and defect, but by the nature of things.

Sir William Armstrong, in his British Association address at York, says:—"Taking a good condensing engine as an example we may roughly say that, dividing the whole heat energy into 10 equal parts, two escape by the chimney, one is lost by radiation and friction, six remain unused when the steam escapes, and only one is realised in useful work."

Ordinary small high pressure engines, in occasional use, waste fully twice as much as this.

Now, a gas engine, for reasons well known to physicists, and established on the 2nd law of thermo-dynamics, is essentially a more efficient engine than a steam engine.

The gas engine is in its infancy, but it has a splendid future before it.

It may seem strange that, instead of burning a ton of coal under the boiler of a steam engine, it should be cheaper to convert that coal into gas, and then explode the gas in a gas engine, but so it is; and not only is it cheaper, but it is really incomparable cheaper. Gas engines almost compare favourably with small steam engines now, with gas at 3s. 4d. a thousand. But supply it at 1s. or 6d. a thousand, and they will entirely eclipse steam. They form a beautiful, compact, smokeless, and perfectly manageable power. Not yet perfect, perhaps. Let us hope not; but wonderfully good considering the short time they have been invented.

But what is the *rôle* of electricity in the power producing?

It is to act as a *distributor*. Produce power it cannot. It has itself to be produced; but it can convey it.

Electricity is essentially the world's traveller.

The quickest known, it is now used mainly for conveying messages. Its next use is to be the conveyance of power. Whether it will ever be docile enough to carry small parcels I cannot say; except, indeed, indirectly, in the electric railway.

The power is to be produced somehow, anyhow so long as it be free from smoke, at a central station.

Perhaps the central station is a waterfall, perhaps a windmill, perhaps a gas engine, very frequently at present a large coke-burning condensing steam engine. Somehow or other a gigantic dynamo, or set of dynamos, is driven at a central station. Wires from it are laid on to the houses and shops of the town; or, in the case of a fall like Niagara, to many of the towns in the United States. A wire is supplied to anyone who will rent it, and the current, after passing through a meter, will turn your coffee mill or your grindstone, or your lathe, or your sewing machine, without the least difficulty whatever.

A big factory may rent a stronger current, and have a 20 or 60 horse dynamo turned by it instead of a steam engine; or, what would probably better, and save a lot of belts and shafting, they might have smaller dynamo-machines arranged in various parts of the building.

[Griscom and other motors were shown; and a number of small motors were arranged in different parts of the theatre, some of them driving sewing machines, another pumping, and so on.]

Now, all these motors are being driven from a central station, the power in this case being typified by an ordinary voltaic battery, and by this hand Gramme machine—which, by the way, will itself be driven by the current in the same direction if I let it go.

[At Liverpool, in addition to small motors, a large Gramme machine on the platform was turned by the current from two similar Grammes in series at an engine house two or three hundred yards away, and was used to drive a circular saw, by means of which a balk of pitch pine, nearly six inches thick, was sawn through slowly, and deal balks were sawn quickly.]

All the motors are now going at once, and they are under central control; for, by pulling out or putting in plugs in this box, I can stop or start any of them. Moreover, local switches are supplied to several, so that the persons near can stop the engine close to without affecting the others. The chairman, for instance, has a switch, by which he can control the Griscom motor which is driving a sewing machine close to him.

You may regard this theatre, then, either as a workshop, or as a manufacturing town, of the immediate future. A central power will be distributed electrically in this simple way.

Dr. Siemens was, I believe, the first to bring the idea of the electrical transmission of power prominently forward. It was of course known to be possible—and that is all that my experiment here shows—but Dr. Siemens has investigated the conditions under which it will be economical. It is now believed to be possible to carry power by a wire or thin rod a distance measured in hundreds of miles without anything like an extravagant loss by the way, and without an extraordinarily thick conductor. So it is quite likely that towns will lay on for themselves the power of a distant waterfall by wires, just as they now lay on the water itself in pipes.

The country is already ramified by thick non-insulated conductors in the shape of railways. The insulated conductors with which it will soon also be ramified need not be so thick as rails.

But there comes the important question of regulation of speed. Return to our hypothetical station, which we will suppose to be a steam engine. A number of dynamos are connected with it, any one of which can be turned on and off by a local will. What is to keep the others working at a steady pace while the circuit of some is being interrupted, or while an excess of work is being thrown on them? A governor on the central steam engine? Yes, but an ordinary governor is of no use here. We do not want the engine to go at a constant speed. It must go fast when more work has to be done, and must slacken when the work drawn off is diminished.

Now, just consider the philosophy of an ordinary governor, and you will see at once how simple is the principle of regulating the speed of electric motors.

In an ordinary workshop the power is transmitted mechanically by belts and shafting, and it is required that every tool shall go at the same pace, whether others are working or not. To this end one of the things driven by a belt is a little centrifugal machine, which, when it goes too fast, shuts off some steam (by hastening the cut-off suppose), and when it goes too slow it

* A lecture delivered by Professor Oliver Lodge, partly at the London Institution and partly at St. George's Hall, Liverpool, in December, 1881.

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admits more steam. That is, it is a machine which keeps itself going at a fairly constant rate. But it is only one of the machines driven by the steam engine, and hence if it goes steadily so do the others.

Now understand, I am supposing all about governors known, I am not taking up your time with explaining them; all I want to lay stress upon is this, to ask you to regard the governor not as part of the engine, but essentially as one of the machines driven by it; a machine, however, which, instead of doing other work, regulates the slide valve, or in some other way governs the engine.

Now look at the electrical case. Here the power is transmitted *electrically*, and we want all the motors to go at a constant pace whether others are working or not. To this end one of the *electric motors* must be made to affect the supply of steam, just in the same way as Watts's centrifugal balls do, so as to keep itself at a steady pace; and then all the others will be steady too. *We want simply a governor driven by the current instead of a governor driven by a belt.*

The effect *on the engine* of the two governors will be quite different, however. The mechanical governor, being mechanically connected with the engine, keeps the engine's speed constant, as well as all the tools whose pace it is intended to keep constant; but the electrical governor will make the engine go fast when much current is wanted, and slow when only a little is wanted.

The engine will have to accommodate its speed to the requirements of the outer world.

I do not know whether this regulating principle for a number of electric motors has yet been published. It has probably struck several people, as it is fairly obvious.

(TO BE CONTINUED.)

ELECTRIC LIGHTING.*

Speaking in this place on electric light, I cannot forget, nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar, illustrious names of Davy and Faraday. It was in connection with this institution that eighty years ago the first electric light experiments were made by Davy, and it was also in connection with this institution that, forty years later, the foundations of the methods by means of which electric lighting has been made useful were strongly laid by Faraday.

I do not propose to describe at any length the method of Davy. I must, however, describe it slightly, if only to make clear the difference between it and the newer system which I wish more particularly to bring under your notice.

The method of Davy consists, as almost all of you know, in producing electrically a stream of white-hot gas between two pieces of carbon.

When electric light is produced in this manner the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electromotive force and a strong current are necessary; in fact, such electromotive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of maintaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed) put a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible by this method to produce individual lights of moderate power.

The electric arc does very well for street lighting, as you all know, from what is to be seen in the city. It also does very well for the illumination of such large enclosed spaces as railway stations. But it is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency. Our hope centres in the method—I will not say the new method—but the method which until within the last few years has not been applied with entire success; but which, within a recent period, has been rendered perfectly practicable—I mean the method of producing light by electrical incandescence.

The fate of electricity as an agent for the production of artifical light in substitution of gas depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light economically through the medium of electrical incandescence, in small quantities or in large quantities, and at a cost not exceeding the cost of the same amount of gas light, then there can be little doubt—there can, I think, be no doubt—that in such a form electric light has a great future before it. I propose, therefore, to explain the principle of this method of lighting by incandescence, to show how it can be applied, and to discuss the question of its cost. When an electrical current traverses a conducting wire a certain amount of resistance is opposed to the passage of the current. One of the effects of this conflict of force is the development of heat. The amount of heat developed depends on the nature of the wire, on its length and thickness, and on the strength of the current which it carries. If the wire be thin and the current strong it may become white hot. The experiment I have just shown illustrates the principle of electric lighting by incandescence, which is briefly this—that a state of white heat may be produced in a continuous solid conductor by passing a sufficiently strong electrical current through it. A principle, the importance of which cannot well be over estimated, underlies this method of producing light electrically—namely, the principle of *divisibility*. By means of electric incandescence it is possible to produce exceedingly small centres of light, even so small as that of the light of a single candle; and with no greater expenditure of power, in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example a platinum wire, the 100th of an inch in diameter, a certain quantity of current would make this wire white-hot whatever its length. If in one case the wire were one inch long, and in another case ten inches long, the same current passing through these two pieces of similar wire, would heat both to precisely the same temperature. But in order to force the the same current through the ten times longer piece, ten times the electromotive force or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electromotive force. Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed. It is therefore evident that whether a short piece of wire or a long piece is electrically heated, the amount of light produced is exactly proportional to the power expended in producing it.

This is extremely important, for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining equal distribution of light. As the illuminating effect of light is inversely as the square of the distance of its source, it follows that where a large space is to be lighted, if the lighting is accomplished by means of centres of light of great power, a much larger total quantity of light has to be employed, in order to make the spaces remotest from these centres sufficiently light, than would be required if the illumination of the space was obtained by numerous smaller lights equally distributed.

In order to practically apply the principle of producing light by the incandescence of an electrically-heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable resistance to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change. As an illustration of the difference that exists among different substances in respect of resistance to the flow of an electric current and consequent tendency to become heated in the act of electrical transmission, here is a wire formed in alternate sections of platinum and silver: the wire is perfectly uniform in diameter, and when I pass an electric current through it, although the current is uniform in every part, yet, as you see, the wire is not uniformly hot, but white-hot only in parts. The white-hot sections are platinum—the dark sections are silver. Platinum offers a resistance to the passage of the electric current, six times as great as silver, and in consequence of this six times as much heat is developed in the platinum as in the silver sections. The high electrical resistance of platinum, and its high melting point mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with ten or twenty per cent. of iridium, an alloy is formed which has a much higher melting point than platinum; and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because high as is the melting point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature. This becomes evident when it is remembered that a strong current is required to raise a wire to even a red heat, and that, when so heated, it emits scarcely any light. The power absorbed in producing heat up to that point is thrown away in so far as production of light is concerned. If the current which made the wire red hot he doubled in quantity, the wire will become white hot, and then it will emit an appreciable amount of light. I will illustrate this by experiment. It will be observed that a considerable amount of current is used in heating the wire up to the temperature at which it begins to be incandescent, and it is only after that point is reached that the current becomes effective in the production of light. One unit of current passed through the filament will only make it red hot. It is at zero as regards light. If the current be doubled the light is at once raised to that of two candles, but one unit more of current at once raises the light to no less than forty candles.

It will readily be understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fulfils this requirement, but there is a non-metallic substance which does so in an eminent degree, and which also possesses another necessary quality, that of low conductivity. The substance is carbon. In attempting to utilise carbon for the purpose in question there are several serious practical difficulties to be overcome. There is, in the first place, the mechanical difficulty arising from its intractibility. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting wires, and to prevent its breaking. If heated white hot in the air, carbon burns away; and, therefore, means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum. During the last forty years, spasmodic efforts have, from time to time, been made to grapple with the many difficulties which surround the use of

* Lecture delivered by Mr. J. W. Swan, at the Royal Institution, on Friday evening, March 10th, 1882.

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carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper, and results finally in the production of very dense carbon. In carbonising these materials it is, of course, necessary to preserve them from contact with the air. This is done by surrounding them with charcoal. Here is an example of a carbon filament produced from parchmentised cotton thread. The filament is not more than the '01 of an inch in diameter, and yet a length of three inches, having, therefore, a surface of nearly the one-tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree. I have said that in order to preserve these slender carbon filaments from combustion they must be placed in a vacuum; and experience has shown that, if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps. In the primitive lamps, the glass shade or globe which enclosed the carbon filament was large, and usually had screw joints, with leather or india rubber washers. The vacuum was made either by filling the lamp with mercury, and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer, or the air was exhausted by a common air pump. The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in the endeavour to obtain durability in the carbon filaments of electric lamps, so that when a well formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass ball, perfectly exhausted by the Spregnel pump, the filament suffers no apparent change even when heated to an extreme degree of whiteness. A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of *any* material, and there must be none of such material as could occlude gas, which, being eventually given out, would spoil the vacuum. There must, besides, be no joints except those made by the glass-blower. Therefore, naturally and perforce of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a simple bulb, pierced by two platinum wires supporting a filament of carbon. Probably the first lamp, having this elementary character, ever exhibited was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle in October, 1877. The vacuum had been produced for me by Mr. Stearn by means of an improved Sprengel pump of his invention. Blackening of the lamp glass, and speedy breaking of the carbons, had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared; and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours continual use. Here are some specimens of the latest and most perfected forms of lamp. You will observe how easily the lamp is attached and detached from the socket which connects it with the conducting wires; and also the variety of fittings to which it can be adapted. The heat produced is comparatively very small. This is conclusively shown by the slowness with which water is heated when a lamp is immersed in it. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electrical machine, with flexible branch to the lamp, or it may be fed by a set of portable store cells closely connected with it. The light is of a quality which brings out colours well. The flowers on the table and the draperies show this, and illustrate its suitability to the lighting of pictures. And now I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is economically practicable. In making this statement I mean that both as regards the cost of the lamp itself and of supplying electricity to illuminate it, light can be produced at a cost which will compare not unfavourably with the cost of gaslight. It is evident that if this opinion can be sustained, lighting by electricity at once assumes a position of the widest possible interest, and of the greatest economic importance; and in view of this I may be permitted to enter with some detail into a consideration of the facts which support it. There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1,200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that a cheap and durable lamp can now be made, the further question is as to the cost of the means of its illumination. This question in its simplest form is that of the more or less economical use of coal; for coal is the principal raw material alike in the production of gas and of electric light. In the one case the coal is consumed in producing gas which is burnt; in the other in producing motive power, and, by its means, electricity. The cost of producing light by means of electric incandescence may be compared with the cost of producing gas light in this way:—2cwt. of coal produces 1,000 cubic feet of gas, and this quantity of gas, of the quality called fifteen-candle gas, will produce 3,000 candle light for one hour. But besides the product of gas, the coal yields certain bye products of almost equal value. I will, therefore, take it that we have in effect 1,000 feet of gas from 1cwt. of coal instead of from two, as is actually the case. And now, as regards the production of electricity. The 1cwt. of coal—that is the same measure as gives 1,000 feet of gas—will give fifty horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle-light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting wires, we make a liberal deduction of twenty-five per cent., and take only 150 candle-light as the nett available product of one horse-power. For fifty horse-power, the produce of one cwt. of coal, we have then 7,500 candle-light, as against 3,000 candle-light from 1,000 feet of gas. That is to say, two and a half times the amount of light which the gas from the same quantity of coal is capable of producing. There still remains, however, an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas burners, gas globes, gas chimneys, &c. I cannot say that I think these charges against gas lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that without a good deal of expense is incurred in the way of renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned—nothing like the full light product which I have allowed to be obtainable from the burning of 1,000 cubic feet of gas, will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas-burners, globes, chimneys, &c. But it will be seen that even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, that there is a wide margin to meet them before we have reached the limit of the cost of gas lighting. I think too it may be fairly taken into account and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable. I have based these computations of cost of electric light on the supposition that the light product of one horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double or even more than double the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost may prove to be compatible with durability of the lamps. In that case the economy of electric lighting will be greater than I have stated. In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas lighting is entirely dependent upon coal—electric lighting is not; but in all probability coal will be the chief source of energy in the case of electric lighting also. When, however, water power is available, electric lighting is in the position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light. To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, the cost of manufacture of electricity and the cost of manufacture of gas. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam engine and incandescent lamps. But here, again in is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half—*i.e.*, debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one half the coal actually used. But when that is done there is still a difference of, probably, three to one in respect of labour in favour of electric lighting. I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the bye products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas. With regard to the cost of plant, I think there will be a more even balance in the two cases. In a gas works you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing and regulating pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam engines, dynamo-electric machines, and batteries for storage. No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and three large stations designed by Mr. Edison are, if I am rightly informed, almost completed in America. We are, therefore, on the point of ascertaining by actual experience what the cost of the works for generating electricity will be. Meanwhile, we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo electric machines of suitably large size. To produce a given quantity of light electrically the cost of plant would not exceed greatly, if at all, the cost of equivalent gas plant.

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There remains to be considered, in connection with this part of the subject, the cost of distribution. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it be found practicable and safe to distribute electricity of comparatively high tension. The importance of this condition will be understood when it is remembered that to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the resistance in the carbon of the lamps should be relatively great to the resistance in the wires which convey the current to them. When lamps are so united with the conducting wire that the current which it conveys is divided amongst them, you have a condition of things in which aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be very short, or, if it be long, it must be very thick, otherwise there will be excessive waste of energy; in fact, it would not be a practical condition of things. In order to supply the current to the lamps economically, there should be comparatively little resistance in the line. A waste of energy through the resistance of the wires of ten or perhaps twenty per cent. might be allowable, but if the current is supplied to the lamps in the manner I have described—that of multiple arc, each lamp being as it were a crossing between two main wires, then—and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use—the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit. Distribution in this manner has the merit of simplicity, it involves no danger to life from accidental shock; moreover, it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system, it would be necessary to have a number of supply stations, perhaps half a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps in series, so that the same current passes through several lamps in succession, or by means of secondary voltaic cells, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

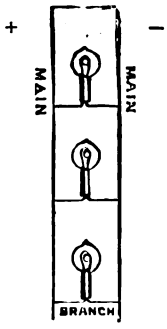

Fig. 1.—Lamps in Multiple Arc.

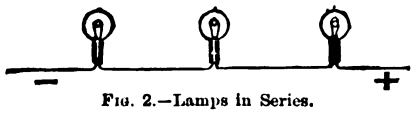

Fig. 2.—Lamps in Series.

Whether by the method of multiple arc (Fig. 1) which necessitates the multiplication of electrical stations; or by means of the simple series (Fig. 2) or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc, I am quite satisfied that comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale. As to the cost of laying wires in a house, I have it on the authority of Sir William Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars—to the entire banishment of gas—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas pipes. I have expended an amount of time on the question of cost which I fear must have been tedious; but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is practically unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas and consequently much yet to be learnt in these respects; yet if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be that the wide substitution of the one form of light for the other is only a question of time.

A Word for the Electric Light.—Mr. Wakefield, at a meeting of the Barnet District Gas Company, speaking of the electric light at the Alhambra Theatre, of which he was a director, said he could tell them to a halfpenny what the light cost and what its results were. He was bound to say that the light there was considered a success. They had had to make some alterations, and had put up an engine at a cost of £500; but the electric lighting certainly saved them from eight to ten pounds a week, and provided equally good illumination.

LECTURES AT THE CRYSTAL PALACE.

FOURTH LECTURE.

The last lecture of this course on electric incandescent lamps suitable for domestic lighting was delivered in the concert room of the Crystal Palace, on Wednesday evening, by Professor Sylvanus P. Thompson, of the University College, Bristol. So far back as 1841 the attempt had been made to construct little electric lamps by enclosing in glass bulbs thin wires of platinum or thin strips of carbon which on the passage of an electric current grew white hot. This method of procuring light from electric currents was revived in 1878 by Mr. Edison, who at first attempted to construct platinum lamps, which, however, in spite of many ingenious contrivances to protect them from overheating, could not be kept from fusing up. Eventually Edison settled upon a filament of carbon, but not before a similar suggestion had been made by Mr. Swan, of Newcastle. Edison prepared his filaments from bamboo fibre, Swan from cotton thread. In each case the carbonised fibre was fixed in a small pear-shaped globe, and exhausted as perfectly as possible of air by a mercurial air-pump. A filament of carbon thus treated became as elastic as steel. Similar lamps had been constructed by Lane-Fox and by Maxim, with slight differences of detail in the manufacture. These little lamps gave a light of about equal brightness to one bright gas jet. They were destined to work a revolution in domestic lighting, since when supplied by currents from a central station they would not only be cheaper than gas, but would be far more readily managed and kept in order. There was no unhealthy smoke or products of combustion produced, very little heat, no smell, and no risk of explosion. The incandescent lamps lent themselves with extraordinary facility to the purposes of decoration, and would doubtless rapidly become the fashionable mode of lighting. The experience of the Savoy Theatre showed that it was practicable to apply them to a large building. The public safety demanded that no time be lost in making electric lighting imperative in all theatres and public buildings. It ought also to be made compulsory to use electric lamps in coal mines. In a few days the experiment would be tried of lighting the Holborn Viaduct and surrounding houses by Edison's lamps from a central station. This would be but a small sample of the method in which domestic electric lighting could be carried out on a large scale. The lecturer predicted for this method of lighting results far more important and wide-reaching than those which any other kind of electric lighting could possibly attain.

MONTEVIDEAN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The ordinary general meeting of the shareholders in this Company was held on the 16th inst., at the offices, King's Arms-yard, Moorgate-street, under the presidency of Sir Thomas Gore Browne, K.C.M.G., C.B.

The Secretary having read the notice convening the meeting,

The Chairman moved the adoption of the report for the year ended December 31 last. It stated that the Company's per centage of the gross earnings of the Western and Brazilian Company amounted in that period to £2,779, the December quarter being estimated at £600. After setting aside £500 for redemption of debentures and providing for all charges and debenture interest accruing during the year, there remained a net balance of £1,102 10s. 6d., out of which it was proposed to pay a divided of 2s. 6d. per share (£1 5s. per cent.), and to carry forward a balance of £63.

The motion was seconded and carried, and the dividend recommended was declared. The retiring director, Mr. C. Cameron, M.P., was re-elected, as was also the auditor, Mr. W. S. Ogle. The meeting then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices March 15.		Business Done Week Ending March 15. Highest.		Lowest	
Anglo-American	52¼,	52¾	53		51¾	
Do. Preferred	82,	83	82¾		81	
Do. Deferred	23½,	24	24		22½	
Brazil Submarine	11,	11½	11½		11⅛	
Cuba	8,	8½	8¾		8¼	
Do. Preference	15½,	16½	15½		15½	
Direct Spanish	5⅞,	6⅛	5⅞		5⅛	
Do. Preference	15⅛,	16	—		—	
Direct United States Cable	11,	11⅛	11⅛		11	
Eastern Telegraph	10,	10½	10½		9 15-16	
Do. 6 per Cent. Preference	12½,	12⅞	12⅞		12½	
Do. 5 per Cent. Debentures, 1899	102,	107	—		—	
Eastern Extension	11,	11⅛	11⅛		11	
German Union	9⅛,	9½	—		—	
Globe Telegraph and Trust Company.	6⅛,	6⅝	6⅝		6 3-16	
Do. Preference	12⅛,	12⅝	12⅝		12⅛	
Great Northern	12,	12⅛	12 5-16		12⅛	
Indo-European	28,	29	—		—	
Mediterranean Extension	1⅜,	2⅛	2⅛		2⅛	
Do. Preference	8¾,	9⅛	—		—	
Reuter's	12¾,	13⅛	—		—	
Submarine	260,	270	—		—	
West India and Panama	1⅛,	1⅜	1 11-16		1⅝	
Do. 1st Preference	7⅛,	8	7⅞		7 9-16	
Western Brazilian	8⅜,	8⅝	8⅛		8 7-16	
West. Union 7 per Cent. 1st Mortgage	123,	128	—		—	
Do. 6 per Cent. Sterling Bonds	101,	104	102		102	

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1⅛	1⅛		1⅛
Oriental	⅜,	½	—		—
United Telephone	13⅛,	13⅜	13⅜		13⅛

ELECTRIC LIGHT.

Eastern Electric Light and Power	3⅜,	3½	—		—
Electric Light and Power	¼,	⅜	11-16		11-16
Anglo-American Brush	8⅛,	8¼	9⅛		9⅛

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SLIP

EDISON ELECTRIC LIGHT COMPANY.—The formation of this company is announced.

BRITISH GUIANA.—The cable between Trinidad and Demerara, interrupted in December last, is now repaired.

ROYAL INSTITUTION.—Last night (Friday) a paper was read by Professor Ayrton, F.R.S., "On Electric Railways."

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 17th March amounted to £3,746.

ELECTRIC LIGHT IN OTTAWA (CANADA).—According to the latest advices from Ottawa arrangements for electric lighting on the tower system were being completed.

THE GREAT NORTHERN TELEGRAPH COMPANY.—The ordinary general meeting of this company will be held in Copenhagen on the 15th April, at 7 p.m., at the Exchange.

THE ELECTRIC LIGHTING BILLS.—In the House of Commons on Monday several private Bills on this subject standing for second reading were postponed until the 18th of April.

THE GERARD PATENTS.—We are informed that the Gerard Electric Light Patents for France have been purchased by the "Societé Anonyme d'Electricité" for the sum of 500,000 francs.

PHYSICAL SOCIETY.—Mr. Shelford Bidwell is to read a paper before this society to-day (Saturday) on the "Effect of Temperature on the Electrical Resistance of Mixtures of Sulphur and Carbon."

DIRECT SPANISH TELEGRAPH COMPANY.—The next general meeting of this company will be held at the Cannon-street Hotel, at 12 noon, on the 31st March. The report of the directors will be found in another column.

WESTERN BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending March 17 were £2,491, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

ELECTRIC LIGHT AT MARSEILLES.—It is stated that the gas company of Marseilles lights its large works in the Prado by means of Brush arc lamps, the current being supplied by a dynamo machine driven by a gas engine.

ELECTRIC LIGHT FOR CLERKENWELL.—The Clerkenwell Vestry have entered into a contract with the Electric Light and Power Generator Company for the lighting of Pentonville-road with Maxim incandescent lamps for one year.

TELEGRAPH AND SORTING CLERKS.—Mr. Fawcett has replied in the affirmative to a question from Mr. A. Morley, asking whether pre-transfer or post-transfer telegraph clerks can be legally compelled to do the work of sorting clerks.

TELEGRAPH AND TELEPHONE WIRES IN THE CITY.—A report from their Streets Committee has been received by the Commissioners of Sewers, in which they state that they are not liable for the breakage of wire stretched across streets.

ELECTRIC LIGHTING COMPANIES IN INDIA.—Messrs. Arbuthnot and Co., of Madras, have relinquished the agency for that Presidency of the Jablochkoff Company, and have undertaken that of the Eastern Electric Light and Power Company.

H.M.S. COLOSSUS.—This ship, the latest and nearly the largest addition to our navy, was launched by the aid of electricity, and in order to enable her to be constructed with greater rapidity, Brush electric lights were used to give light for the workmen at night.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended March 15 are £3,430, as compared with £2,539 in the corresponding period of 1881. The December receipts, estimated at £4,796, realised £4,882.

SOCIETY OF ENGINEERS.—The discussion on the paper on "Notes on Electric Light Engineering," recently read before this society, was continued on Monday last at the society's rooms, 6, Victoria-chambers, S.W., and was again adjourned to that day fortnight, viz., the 3rd of April.

REPLY TELEGRAMS.—In the House of Commons, on Thursday week, Mr. Fawcett stated, in reply to Mr. Alderman Lawrence, that after giving careful consideration to the subject of allowing sixpenny replies to ten-word telegrams, he did not see his way to acceding to the suggestion.

ELECTRIC LIGHT FOR RAILWAY STATIONS.—The Northern of France Railway Company is about to experiment with the electric light as a means of illuminating its station at Lens (Pas-de-Calais). Should the experiment prove satisfactory the light will be used in all the principal stations of the company.

S.S. "COTOPAXI."—We omitted to state in our recent note that the patent ozokerit core, manufactured by Henley's Telegraph Works Company, was used by Messrs. Crompton and Company in fitting this ship with incandescent lamps. This core has, we believe, been put to severe tests and given good results.

THE BRUSH LIGHT IN THE CITY.—At a recent meeting of the Court of Common Council Mr. Felton, chairman of the Commissioners of Sewers, stated that in one area of the City the cost of the electric light on the Brush system for the year had been £30 less than the previous charge for gas in a similar period.

ELECTRIC LIGHT AT CHESTERFIELD.—The Hammond Electric Light and Power Supply Company (Limited) have informed the Chesterfield Corporation that they are now able to carry out their contract in an efficient manner, and that in a few days the borough will be thoroughly illuminated by a system of incandescent lamps.

ELECTRIC LIGHTING AT RANGOON.—The Eastern Electric Light and Power Company have received a telegram from their managing director in India, announcing that a contract with the municipality of Rangoon has been concluded for a sum of 50,000 rupees per annum. Both the Brush arc lamp and Lane-Fox incandescent lamp will be employed.

THE ELECTRIC LIGHT AND PICTURES.—Recently Swan's incandescent lamps were used for the first time to light Hans Makart's colossal painting of Diana's Hunting Party, in the Central Exchange Art Gallery, Newcastle. According to the *Newcastle Chronicle* the effect was superb. Every shade of colour was brought out with marvellous distinctness.

THE LOWESTOFT CABLE REPAIRED.—The German Union Telegraph Company (Limited) notify the repair of its cable between Norderney and Lowestoft, thus restoring direct telegraphic communication between England and Germany. It is expected that the duplicate line between Germany and Valentia will be laid and open for traffic next month.

ELECTRIC LIGHT FOR SYDNEY.—The *Colonies and India* announces that some London capitalists have offered to light the streets of Sydney by electricity at 25 per cent. less cost than that now expended on gas, but that the City Council,

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before entertaining the offer, have resolved to ascertain full particulars of electric lighting from Swan and Edison.

Utilisation of Water Power.—The employment of water as a motive power in the generation of electricity is shortly to be practically demonstrated at Penang. We understand that the Eastern Electric Light and Power Company have acquired a concession of the great waterfall at Penang, and that special machinery is in course of construction for the utilisation of the water power to drive their machines.

Edison's Lamps for Church Lighting.—The City Temple, in Holborn Viaduct, was lit up last Sunday night for the first time by means of Edison's incandescent lamps. The current was supplied from the generating station near by on the Viaduct. There were 170 lamps in use. The light appears to have given great satisfaction to the large congregation who were present, and it may be remarked that despite the increased attendance the temperature of the church was lower by several degrees (ten is the number mentioned by some) than on the previous Sunday, when gas was used.

Electric Light in the City.—A report by the engineer, recommending for acceptance the offer of the Brush Electric Light Company to continue the lighting of District No. 1 for another year for £800, as against £660, their present charge, and proposing to give this company the lighting of No. 3 District, hitherto lighted by Messrs. Siemens, was agreed to at the meeting of the Commissioners of Sewers on Tuesday. The lighting of District No. 2, in which the Electric Light and Power Generator Company have recently erected a number of improved Weston lamps, which give an excellent light, has not yet been settled.

Eastern Extension Telegraph Company.—This Company announce that their accounts to December 31 last show (subject to audit) a balance of profit of £121,196 after payment of three interim dividends and a bonus for the first half-year. Against this sum the board have charged £34,363 in part payment of the new Singapore-Batavia Cable, and they now propose to pay a final dividend of 2s. 6d. per share, together with a bonus of 1s. per share (both free of income tax), making, with previous distributions, a total payment of 6 per cent. for the year 1881. A balance of £51,876 is carried to the reserve fund, which now stands at £276,203.

The Telephone Suit.—An application was made in the Court of Session, Edinburgh, on the 16th instant, by the United Telephone Company, for leave to borrow certain documents and models which were made use of in the recent case of Maclean v. The United Telephone Company, for the purposes of a similar trial which is to take place in London next month. This application was granted on condition that the models, &c., were taken back to Edinburgh in time to prepare for the hearing of the reclaiming note which has been lodged by the plaintiff against Lord M'Laren's recent judgment as to the validity of the Company's patents. This judgment was very fully given in a recent number of *The Electrician*.

Telegraphic Reforms.—A correspondent of the *Glasgow Herald* writes as follows:—"The suggestions I would make are these—first, registration of addresses at 5s.; second, the use of figures to be extended to inland telegrams, up to five figures to form one word; third, that sixpenny telegrams consist of ten words, addresses to be included; fourth, that words of over ten letters be counted as two words; fifth, ninepenny telegrams to be of fifteen words, and 1s. telegrams of twenty words. Objection may be raised to the increase of charge in the 1s. telegrams, or, rather, I would say, the reduction of words, but this would only necessitate all business firms having the registered address, and the giving the privilege of using figures would more than counterbalance the extra charge."

Crystal Palace Exhibition.—On Monday last a visit was paid to this Exhibition by Mr. and Mrs. Gladstone, Earl and Countess Granville, Earl and Countess Derby, and a distinguished party, who were the guests of Mr. John Pender, M.P. The visitors travelled to the Palace in the new Pullman car train, which is lighted by Edison lamps and Faure accumulators. After having inspected the various exhibits, the visitors dined with Mr. Pender. On Wednesday evening the Chemical Society, the Institute of Chemistry, and the Society of Chemical Industry, held a combined reception at the Palace, the guests being received by the Presidents, Professor Roscoe and Professor Abel, in the Concert Room. The visitors numbered about 1,000. On Saturday (to-day) the Prince and Princess of Wales are to visit the Exhibition.

Telegraphic Communication with Lighthouses.—In the House of Commons, on Monday, Mr. Akers Douglas asked the President of the Board of Trade whether any steps had yet been taken to secure telegraphic communication from lighthouses and lightships with the shore. Mr. Chamberlain replied that the Board of Trade were some time ago in communication with the Trinity House on the subject of telegraphic communication between the shore and lightships, and he informed them that he would sanction a communication of the kind mentioned with one lightship as an experiment. He had since been informed that they had been in negotiation for connecting the Sunk lightship with the shore. Some arrangement had still to be made with the Post Office; but he believed that within a fortnight the matter would be complete. While he was of opinion that it was desirable to make this experiment, it would be a costly one, and he was rather doubtful at present whether the expense would be justified by the result.

Lightning and Blasting Operations.—According to the *New York Times*, a premature explosion of blasting cartridges was produced in the new tunnel of the New York, Ontario, and Western Railroad, above Hoboken, on the 21st of February last. It appears that the wires usually employed to supply the electric lamps in the tunnel were used for the purpose of firing the charges, being disconnected from the electric light system for the moment and connected with the cartridges. There were only sixteen men in the shaft, and the work of connecting the wires had commenced, when a flash of lightning occurred which traversed the conductors and produced an explosion. There had been a flash previous to this, which had simply caused a slight perturbation of the lights in the tunnel, but did not extinguish them. Fortunately none of the men employed in the shaft were fatally hurt by the untimely explosion. Miners employing electricity in firing charges will do well to suspend blasting during storms in winter as well as in summer.

The Telephone in Belgium.—Experiments have recently been made in Brussels with telephones into which improvements have been introduced by M. Van Rysselberghe. The first experiments were made between the Eastern Railway Station at Antwerp and the Northern Station at Brussels. A message of 200 words in cypher (figures being used) was transmitted, with the result that only two figures were wrong. The second experiment was made between the observatory at Brussels and the meteorological station at Ostend, a distance of 125 kilometres, along a telegraph wire belonging

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to Government, and used to carry the international traffic between London and the Continent generally. This line is worked by Hughes' instruments. The experiment took place between two and three o'clock, when the exchanges were closed, and when the traffic was greatest. The line was not in a good condition either, as it was a rainy day. Conversation could, however, be carried on without interruption, although the induction noises were sometimes disagreeable. It is stated that the Ostend meteorological station is now in regular telephonic communication with the Brussels Observatory. As M. Van Rysselberghe's improvements have been patented, details cannot be published, but are promised before long.

THE TELEPHONE IN GERMANY.—According to a report recently issued by the German Post Office there are 1,280 telephone offices in the country. This instrument was first introduced in November, 1877, but was not largely used by the public for some time after. Mühlhausen was the first to adopt it, followed later on by Berlin. In April, 1881, there were in Berlin 87 subscribers to the telephone exchange. The number of calls in Berlin are now increasing by about 6,000 per month. There are three central stations, in Französische, Mauer, and Oranienburger streets respectively. In the first three weeks of December last it appears that, on an average, 1,650 connections were made daily. From 12 to 1 is the busiest time; during that hour 150 connections, on an average, were made in the office in Französische-strasse, or five every two minutes. From 3 to 4 there is a little rest, and from 5 to 7 fresh activity. The telephone chambers in the Exchange have double walls, with ashes, clay, or sawdust between; the inner walls have intervening a layer of thick paste-board, then cotton-covered felt on frames, and on this the paper. These chambers answer very well and are much frequented. There are also two public telephone rooms where, on payment of 50 pfennig (5d.) any person can have five minutes' talk by telephone with any one whose home or office is in the system.

A NEW THREE CYLINDER ENGINE.—We had an opportunity last week of inspecting a new three-cylinder type of engine which has just been brought out by Messrs. James and Wardrop, of Princes-street, Commercial-road, Lambeth, S.E., as specially suitable for direct driving of high speed machinery or dynamos. At the time of our visit the engine was running light, and we had no opportunity of testing its steadiness for current-producing purposes, as there was no suitable apparatus on the premises. Judging, however, by the freedom from shake while running at between 300 and 400 revolutions, merely clamped down to a temporary bed-plate, we can quite understand that at 800 revolutions, which the makers intend working up to when properly fixed, there would be great freedom from objectionable vibration. The engine is very compact, the one we saw occupying only 3ft. 6in. by 4ft., and 5ft. by 6in. high over all. 6in. cylinders with 6in. stroke at 800 revolutions gave 40 h.-p. indicated, we believe. Where space is a consideration even these dimensions could be lessened. The design provides specially large bearing surfaces, easily accessible for lubrication. The power can be taken from either or from both sides of the engine, and the machinery can either be driven direct or from the periphery of the flywheel as desired. The engine can also be made to work compound by using two of the cylinders as high pressure and the other as the low pressure, with probably a considerable economy of steam. All wrought parts are of steel, the work is well finished, without any outlay being put into mere polish, and the governor is very sensitive.

ELECTRICITY ON RAILWAYS.—*La Lumière Electrique* gives some further details of the experiments recently made between Paris and Gretz, which we alluded to in a recent note. Our contemporary says:—"In the evening of the 9th March some very interesting experiments were made on the Eastern Railway between Paris and Gretz. The train was fitted with electric connections, and batteries actuating alarum bells of a new kind. It also carried two Gramme machines and Tommasi accumulators. One of the machines was placed on the locomotive, and was driven by a Brotherhood engine; the current generated by it served to actuate Achard's continuous electric brake, improvements in which have been made by the Eastern Railway Company's engineers. The action of this brake was in every way satisfactory. The second Gramme machine was placed in the brake van, and driven by means of belting from the axle. It was only set in motion, therefore, when the train was moving, and, with the help of the accumulators, furnished the current for lighting the carriages. Of these there were 13, including two brake vans. Maxim incandescent lamps, to the number of 31 were used. The accumulator cells, although there were 96, weighing about 3,800 kilos. (8,360lbs.), did not give good results; it seemed certain that they had not been sufficiently charged. It will be necessary to repeat the experiment as far as this part is concerned. The Gramme machine, on the other hand, when the train was going at a fair speed, caused the lamps to give an excellent light. The experiments were conducted under the superintendence of M. Regraz, chief engineer to the company."

FIRE RISK AT THE CRYSTAL PALACE.—A good deal of vexation of spirit has been caused in the minds of the directors of the Crystal Palace Company and of the exhibitors thereat. The fire offices having duly considered the extra fire risks involved in the Electrical Exhibition have promptly agreed to charge something like double the usual premiums. Some offices, in fact, refuse to accept any risk at all on the building or contents. We observed on Wednesday evening last, that at a particular juncture of a very interesting lecture by Professor Thompson, a good deal of force was impressed by him upon the proposition that the electric lighting was infinitely safer than that by gas or any other means. By the vigorous manner in which this sentiment was applauded, both amongst the audience and by the secretary of the company, who was on the platform, it would appear as if a great many of the shareholders were present. We must point out, however, that there is some little mistake here. The reason why premiums have been increased in the case of the Crystal Palace is not on account of the electric lighting. It is because there are a very large number of steam engines erected in the Palace, and that as every inventor has his own steam engine, his own gang of workmen, his own boiler and stoker, &c., the chances of fire are enormously increased. It is by reason of the proximity of furnaces, steam engines, &c., to inflammable material, and not in consequence of the introduction of electricity for illuminating purposes into the building. This subject should be clearly understood by the shareholders of the Crystal Palace Company and the exhibitors as well, if only to vindicate the claims of the electric light to be considered as an eligible fire risk. As far as we have been able to see, the wires are insulated with great care, and present, as Professor Thompson justly said, that appearance of safety which is so ardently desired by fire insurance companies. Under the principles upon which Mr. Edison is carrying out his house-to-house system of electric lighting there can be no doubt that the fire risk will be greatly reduced. —*Review.*

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CORRESPONDENCE.

POST OFFICE TELEGRAPH DEPARTMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read with much pleasure the letters of "Totum" and "Technological" in your issue for March 18, and offer my testimony in support of their remarks *re* technical knowledge. I was peremptorily told that such knowledge was of no earthly use to any one, and would have no weight with the Department. For years I have studied our varied apparatus, but on the receipt of such information I have naturally turned my studies to other subjects.

This system is, however, keeping back the application of the sixpenny tariff.—Yours, &c., ELECTRIC.

TO CORRESPONDENT.

WIRE COVERING MACHINERY.—Will our correspondent, "A. E. I.," kindly send his address, and we will communicate further with him on this subject.

HYDRO-ELECTRICITY.

The hydro-electric analogies of Professor Bjerkness, which excited so much attention at the Electrical Exhibition recently held in Paris, have been extended by M. C. Decharme, who instead of employing pulsating drums uses only liquid currents, continuous or interrupted, operating in the air or water. Just as Bjerkness applied to liquids the observed fact that a vibrating tuning fork will attract a light floating body such as a balloon so does M. Decharme apply to liquids the fact discovered by M. Clement Desormes, that a jet of gas will attract a disc of cardboard held near and normal to it, provided the jet issues from a tube furnished with a similar disc flush with the opening. The corresponding experiment with a liquid can be made by help of a water hose. The hose is placed vertically, and has a metal disc flush with the opening turned upwards. A second disc is approached near the first, taking care only to keep it from gliding. Under the influence of the jet, this disc is attracted and kept at two millimetres or three millimetres from the fixed disc, by the difference between the pressure of the surrounding air, and that of the water between the discs. The movable piece is not in contact with the fixed tube, but when it is desired to draw it from its position of equilibrium one feels a very pronounced resistance. M. Decharme, however, finds that the disc fixed to the tube can be suppressed provided a nozzle with thick lips is used, and of a converging conical shape. The attraction of the movable disc is, it is true, diminished. Further on, reversing matters and making the plate fixed, say a slab of bitumen on the pavement, the nozzle if held vertically over it, will be attracted until it strikes the plate, then it will recede, and be attracted again, thus setting up vertical vibrations. If the nozzle has thin lips the same vibratory effect will be set up by *repulsion*. This experiment can be likened to an electro-magnet interrupted automatically by the movement which determines the current itself as in electric trembler bells. To produce a "hydro-electro-magnet" with two opposite poles, it is necessary to have a branching pipe with two nozzles, one thick-lipped, the other thin. To produce a double effect, it is simply necessary to have two nozzles of the same sort. The arrangement of a free plate and a fixed tube is the analogy of a permanent magnet or an electro-magnet active during the time the current flows. According as the lips of the pipe nozzle are thick or thin, the force between the plate-tube will be an attraction or repulsion. These effects rapidly increase in intensity as the distance between the nozzle and plate is diminished. On interrupting the current of water by closing the stopcock a sensible recoil is felt; on letting the current flow a sensible advance is felt. These effects easily explain themselves: the first is analogous to the hydraulic tourniquet, the second a sort of hydraulic ram. If, then, it be permitted to compare the liquid stream to an inducing voltaic current and tube to the induced wire surrounding the inducing one, the phenomena described are analogous to those that an electric current alternately open and closed produces in the induced wire. Moreover, the hydro-dynamic movements are instantaneous like the induced currents; that is, only manifest themselves at the same moment as the passage or the interruption of the current. During its duration there is no dynamic effect; that is, the position of the tube remains invariable. Again, when an inducing current commences, it determines a reverse current in the induced wire, and when it stops a direct current. Now, in the water analogy, when the current begins, there is repulsion in the tube and a movement of recoil inverse to the liquid stream, while at the moment of interruption there is attraction or an advance in the tube.

EXPERIMENTS TO DETERMINE THE VALUE OF THE BRITISH ASSOCIATION UNIT OF RESISTANCE IN ABSOLUTE MEASURE.*

BY LORD RAYLEIGH, PROFESSOR OF EXPERIMENTAL PHYSICS IN THE UNIVERSITY OF CAMBRIDGE.

This paper contains an account of a repetition by Dr. Schuster, Mrs. Sidgwick, and myself, of the British Association experiment on the unit of resistance with an improved apparatus. Three distinct series of observations were taken, of which the first two were more or less imperfect. In the third series an extraordinary concordance in the results obtained on different occasions at the same speed of rotation was arrived at, but the numbers corresponding to the four speeds could not be perfectly harmonised on the basis of an *à priori* calculation of the self-induction.

TABLE VII.—THIRD SERIES.

Number of teeth	60.	45.	35.	30.	Mean.
Resistance of standard at 13deg., uncorrected	23·619	23·621	23·630	23·638	23·627
Correction proportional to square of speed	0·006	0·011	0·018	0·025	...
Resistance of standard at 13deg., corrected	23·613	23·610	23·612	23·613	23·612

Table VII. gives the results of the series. The "number of teeth" in the first row is inversely as the speed of rotation. The second row gives the resistance of a certain platinum-silver standard at 13° in absolute measure, as calculated with a value of the self-induction derived from evidence independent of the spinnings. The simple mean of these numbers is 23·627 ($\times 10^9$ C.-G.-S.), but they exhibit a well-marked tendency to rise with the speed. In the third row are numbers proportional to the squares of the speeds, by subtraction of which a practically perfect agreement is arrived at. The mean 23·612 thus represents the result of the investigation, if the effect of self-induction be determined from the spinnings themselves, and is to be preferred for reasons explained in the paper to the simple mean 23·627. The difference is, however, less than one part in a thousand.

The resistance at 13° of the same coil in terms of B.A. units is 23·935 from which we find

$$1 \text{ B.A. unit} = \cdot 98651 \frac{\text{earth quadrant}}{\text{second}}.$$

This number is somewhat lower than that which we obtained (·9893) with the original apparatus.† but it agrees with that required to reconcile Dr. Joule's thermal determinations. Rowland's value is distinctly higher (·9911), while Kohlrausch obtained 1·02. No satisfactory reconciliation of these results is arrived at, but some remarks are made upon the relative merits of the various methods.

* Abstract of Paper read before the Royal Society.

† *Proc. Roy. Soc.*, Vol. 32, p. 141.

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VAN RYSSELBERGHE'S AND SCHUBART'S METEOROGRAPH.

This instrument, which has been termed a meteorograph, automatically registers at a distance, in the form of continuous curves, at intervals of ten minutes, the following information:—1. Height of the barometer; 2. Reading of the dry thermometer; 3. Ditto of the wet ditto; 4. Direction of the wind; 5. Velocity of ditto; 6. Amount of rainfall. The readings are registered on a sheet of zinc wound on a cylinder, coated with varnish, on which lines are engraved by means of a small steel point or a diamond. The figure shows the apparatus at work.

Any number of copies can be taken from the original sheet of tracings after having placed it in a solution of perchloride of iron in order to increase the depth of the lines traced.

Rysselberghe's scheme for universal meteorography includes two kinds of apparatus:—1. Local registers established at each station, which register the phenomena indicated by the various apparatus at the local station. 2. Central registers, established at central stations, which record at a certain number of stations the observations made at all the local stations.

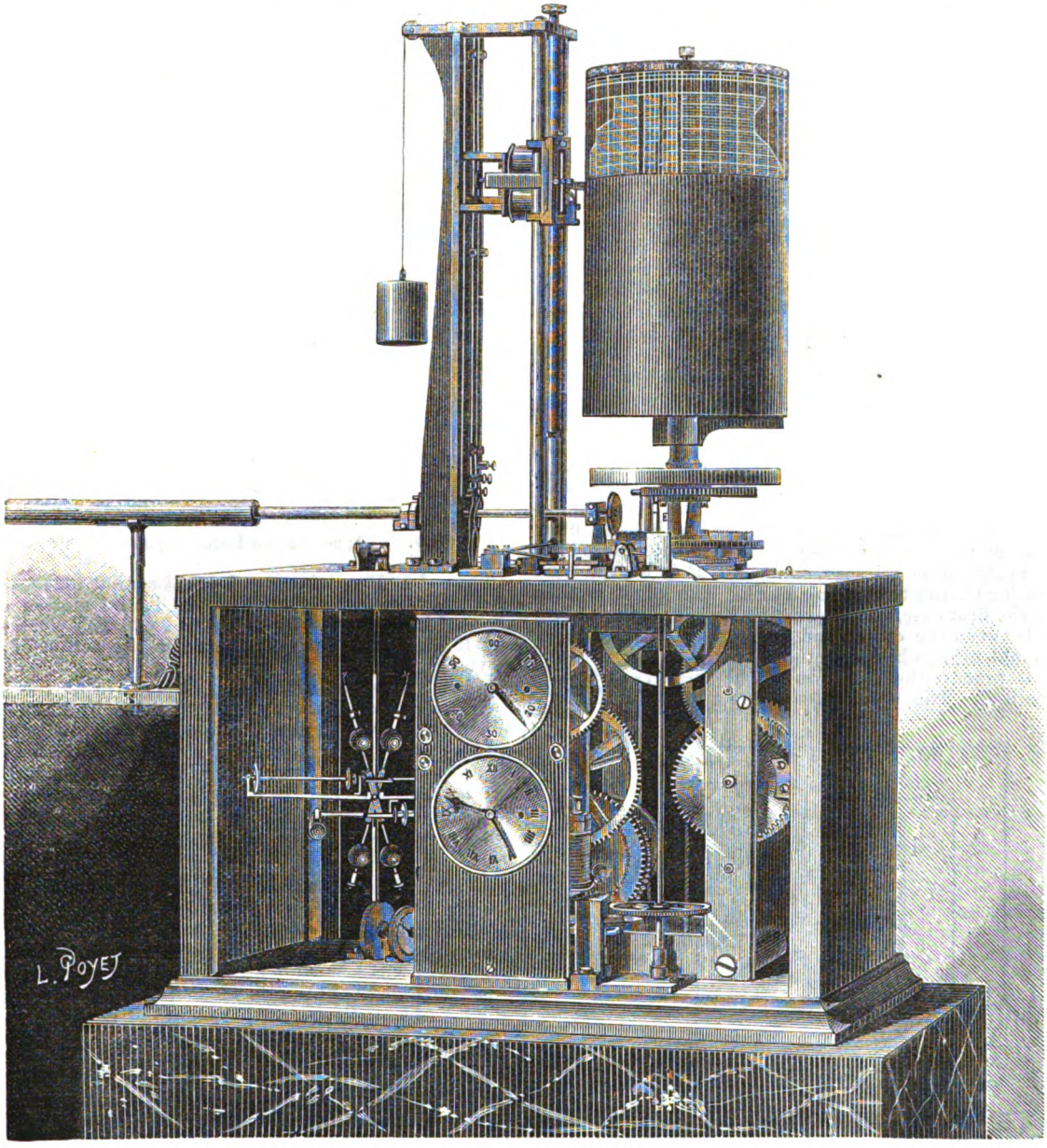

FIG. 1.—Rysselberghe's and Schubart's Meteorograph.

The figure illustrates a local register. We will first glance at the principle employed in registering a particular indication—say, the height of the barometer. It will then be easy to understand that of the thermometer, which is almost identical.

Fig. 2 shows a diagram of the registering apparatus. The barometer is a syphon, with arms of equal diameter; it is, therefore, only necessary to note the variations in the open arm. C is the registering cylinder, set in motion every ten minutes by clockwork, which causes it to make a complete revolution every minute and a half, during which time six registrations will have been carried out. On the axis of C are fixed two toothed half-wheels, B^1 and B^2, engaging another toothed-wheel, D, alternately at the top and bottom as shown, D being fixed on the same axis as another wheel which moves simultaneously with the rod E. The platinum dipper S, connected with the rod E, will rise and fall the same distance for a complete revolution of the cylinder. Supposing the rod E were connected to the negative, and the mercury of the barometer to the positive pole of a battery, through the intermediary electro-magnet M, in front of which is an armature, which in its ordinary position keeps the steel point P from touching the cylinder, but which causes it to approach it immediately a current traverses M. The point P will trace a line on the cylinder during the time that the current is passing in the electro-magnet, that is to say during one revolution of the cylinder, so long as the dipper S is in contact with the mercury. The position of the point of contact of the point P with the cylinder, and, consequently, of the first portion of the line traced, will depend on the height of the mercury in the barometer; a datum line once established will thus enable the exact barometric pressure to be obtained. If the register were constructed in practice according to the above explanation, the lines made by the engraver would continue until the circuit was broken by the dipper S emerging from the mercury; the result of this would be a small spark which would oxydise the mercury and soon render the apparatus useless. To avoid this difficulty the

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current does not go direct to the rod E. It passes by a metal half-wheel, on which press two rubbing contact pieces, F^1 and F^2; contact ceases directly the rod E begins its upward movement—that is to say, at the lowest point of its path. The current also ceases before the dipper emerges from the mercury; there is, therefore, no spark. The same thing occurs every ten minutes; each time that the cylinder C makes a revolution the engraver descends slightly. In order to render the lines traced, parallel, the tracings begin at a fixed time, which depends on the height of the mercury in the barometer, but they always end at exactly the same time as the rotation of the cylinder. All the interruptions of the working are caused by the same generator, which renders the control of the apparatus simple.

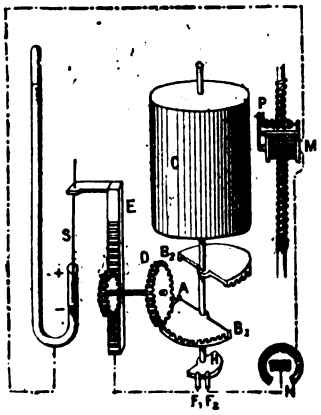

FIG. 2.—Apparatus for Recording Barometer Readings.

Another modification of the above is shown in Fig. 3. The current sent from the barometer does not act on the electro-magnet M, which governs the engraver, but on a relay, N, corresponding to a local battery. The current from N acts when the cylinders revolve, and the tracing is produced until the dipper makes contact with the mercury. At this moment the tracing current is interrupted by the relay, the armature is released, the point P is drawn back from the cylinder C, and the tracing stops. The effect is thus the inverse of the first case, and the tracing lasts so long as there is no contact between the dipper and the mercury. The end of the dipper should always be connected with the positive pole of the battery; to procure the reduction of the mercury it should be a little oxydised. This will always insure a bright surface.

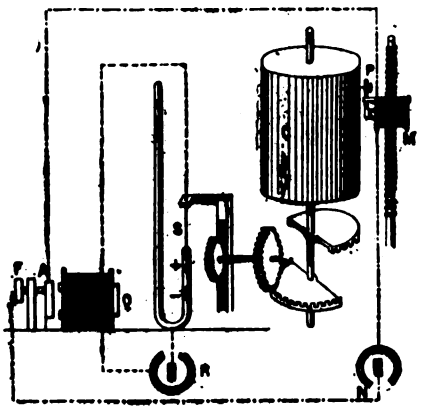

FIG. 3.—Apparatus for Recording Barometer Readings.

The working of the apparatus with a thermometer or psychrometer is identical with the above arrangements; but in this case there is a special difficulty to be overcome, due to the fact that if the dipper enters the mercury, as in the barometer, the column would be quickly divided. It is necessary, therefore, to cause it to stop at the moment when it touches the surface of the mercury. Again, the wet thermometer always records a lower temperature than the dry one; the latter, therefore, traces a line so long as the dipper S (Fig. 4) does not touch the mercury; consequently, the engraver does not make contact until the dipper S′ touches the mercury of T′, and traces a line until the current is interrupted. The white interval which separates the thermometers gives the difference between their readings.

The rods T and T′ of the two thermometers are bent at right angles. The dippers S and S′ are fixed on independent rods E E′, ending in a cross piece fitted to the rod set in motion by the wheel D, as in the case of the barometer. The two dippers are in connection with the positive pole of the battery, the negative pole being connected with the mercury of the thermometers by means of a wire and two electro-magnets, R and R′, which respectively become active when the corresponding rod touches the mercury.

When R is in action it attracts its armature, which causes the movable piece K to engage two teeth of F, and thus prevents the dipper from descending lower.

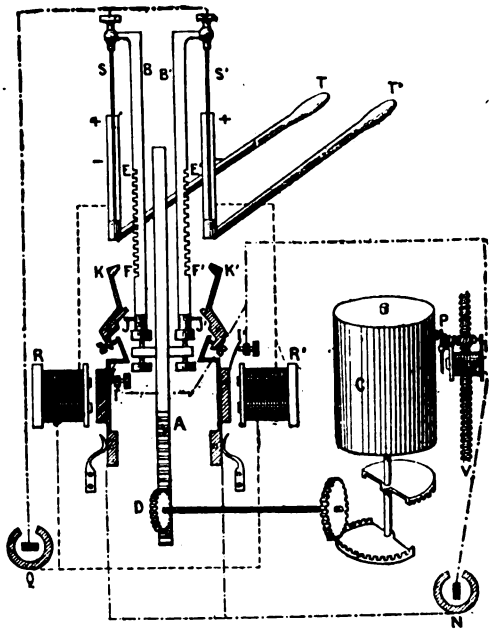

FIG. 4.—Apparatus for Recording Thermometer Readings.

The rod E′ F′ continues to descend until it touches the mercury of T′, always lower than that of T, the motion of S′ is then arrested in the same way as that of S. The electro-magnets R and R′ also act as relays, and govern the action of the current on the engraver.

When the wheel commences to revolve at the beginning of each observation, the current of N passes by I and traces a line. When the dipper S meets the mercury of T, the current from Q enters the electro-magnet R, the connection with I is broken by the influence of R, the engraver is drawn back, and the tracing ceases. A little later the dipper S′ meets the mercury in T′, the current from Q enters R′, and acts on I through the displacement of armature R′. The engraver then begins to make a tracing, which is continued until the current is entirely cut off by the wheel D revolving in an opposite direction.

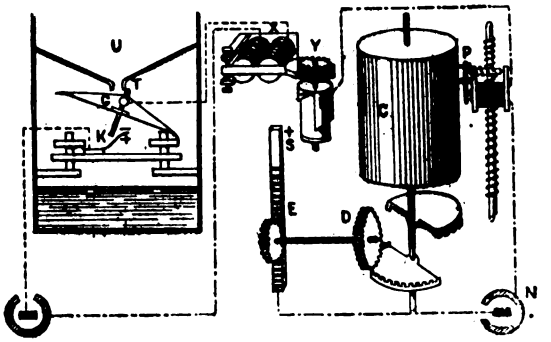

FIG. 5.—Apparatus for Recording amount of Rainfall.

During the return motion of the rod A the pieces K K′ take up their positions to commence work again ten minutes later on.

Udometer or Rainfall Recorder.

The rain is collected in a pluviometer of given capacity, which collects the water upon a balance with troughs, which inclines first to one side and then to the other each time that 10 grammes of water (corresponding to a height of rainfall of 1 millimeter) have fallen into one of the troughs (Fig. 5). Each movement of

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the balance causes electrical contact to be made at K, which transmits a current to the electro-magnet X. The armature of this latter causes the ratchet wheel Y to advance one tooth. In two successive intervals of ten minutes, therefore, the wheel Y and the cylinder H should have revolved by as many teeth as quantities of 10 grammes of water shall have fallen on the surface of the udometer. The cylinder H is fitted with a piece of metal of helical shape which is connected with the negative pole of the circuit comprising the electro-magnet M of the engraver, whilst the positive pole is connected with a vertical rod E, actuated by wheel D, and carrying at its upper end a finger S, which at a given time makes contact with the helical covering of cylinder H. At this moment a current is set up, and the point is kept in contact with the cylinder until the rod E begins its return movement, when the current is interrupted. U is the rain collector, G the balance, and K the point of contact when the balance is caused to oscillate.

Direction of the Wind.

This is determined by the position of the vane, the axis of which carries a metal disc P Q (Fig. 6), which revolves with it; this disc has a glass sector, N′, equal to $\frac{1}{16}$ of its circumference, the middle of which gives the exact direction of the vane. An insulated circle, placed under the metal disc, carries nine contact pieces, which bear against the metal disc. When the latter revolve, the glass sector passes under each of these, and, by reason of its size, is always in contact with at least one, but not more than two, of them. These contact pieces are connected with insulated pieces of metal, against which a spring, F′, carried by a rod, C D, is made to press, this rod being actuated in the same way as in the case of the barometer, &c. Eight of the contact pieces of the disc correspond to the directions of the

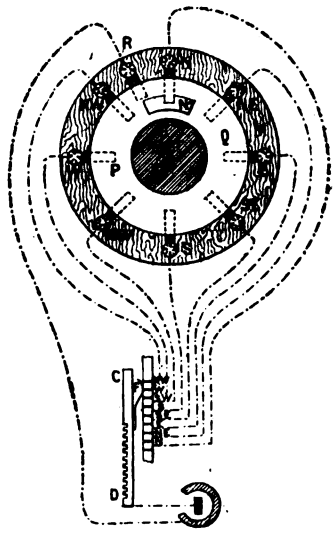

FIG. 6.—Apparatus for Recording Direction of Wind.

cardinal points, the ninth, R, is connected with the negative pole of the battery, and presses against the metal disc, but is so arranged as never to be touched by the glass sector. The working of the apparatus is as follows:—When the spring F of the rod C D passes along the fixed rod, the circuit is closed, excepting when one of the fixed contact pieces of the vane touches the glass sector. At this instant the current is interrupted; there are two successive interruptions when the vane occupies an intermediate position, which enables eight directions to be exactly determined, and sixteen to be approximately estimated.

The Velocity of the Wind.

The apparatus registers the velocity of the wind during ten minutes, or, rather, registers the number of revolutions made by the anemometer during an interval of ten minutes, and from this the corresponding velocity is deduced. The registering mechanism is composed of a combination of the ratchet wheel of the udometer and the rod with insulated metal contact pieces of the vane (Figs. 5 and 6). The order of actual registration in the meteorograph is as follows:—1. Dry bulb thermometer, 2. Wet bulb ditto, 3. Udometer, 4. Direction of wind, 5. Barometer, 6. Velocity of wind.

All the mechanism is actuated by clockwork furnished with an isochronic fan and centrifugal force regulator of great sensitiveness and precision. The clockwork movement is never stopped, owing to its not having to overcome the inertia of heavy masses at starting; the registering mechanism alone is stopped. Every ten minutes an electric contact made by a clock causes it to be set in action by sending a current to a special electro-magnet, and when the cylinder has made one entire revolution, in a minute and a half that is, the stoppage again takes place automatically.

The parallel lines traced every ten minutes are produced by causing the whole engraving apparatus to be lowered a certain space by a counterpoise, as shown in the general view of the apparatus. (Fig. 1.) The descent is greater every two hours, thus producing a blank space every two hours, which is of use in reading off the observations.

We may now explain how the vertical lines are traced, which form a kind of quadrilateral, permitting the value of the ordinates corresponding to each phenomenon to be determined. By an ingenious arrangement the apparatus is made to trace the ordinates in white, whilst the other lines are traced in black.

This result is thus obtained. The electro-magnet of the tracing apparatus is wound with two wires, one of which is connected with the registering relays previously mentioned; and the other with a toothed wheel revolving with the cylinder C, and carrying a series of insulated pieces, regularly distributed over its surface. A rubbing contact piece presses against this wheel. When the contact piece touches a non-insulated part the whole current of the battery passes by the short path offered to it by the metal contact, and does not traverse the second wire of the electro-magnet. When, on the contrary, the contact piece presses on an insulated portion of the wheel, the shunt no longer exists, and the current traverses the second wire of the electro-magnet of the engraver. At each revolution of the cylinder, therefore, there is a regular series of currents which traverse the second wire, these currents being quite independent also of those of the registering relays.

The direction or character of the current in the second wire is such as to counteract the action of that of the relays when it passes at the same time in the electro-magnet of the engraver. This is a differential system—what takes place is:—

1. If the engraver is not in contact, the passage of the current in the second circuit has the effect of causing the engraver to make contact for an instant and engrave a point.

2. If the engraver is in contact, the regular emissions of current through the second electro-magnet will have the effect of destroying the magnetism produced by the registering current, and the engraver will be drawn back from the cylinder, leaving a blank. In the two cases the register is made in either white on black, or black on white. Every five minutes a slightly longer contact is made to take place to render it easier to read the diagram.

THE EFFECT OF FLAME ON THE ELECTRIC DISCHARGE.*

BY DR. A. MACFARLANE AND MR. D. RINTOUL.

The flames experimented with were produced by means of a Bunsen burner, and were either luminous or non-luminous; the charged body was a disc placed at the side of the flame, and the charge was of either kind. The results deduced from a methodical series of measurements and observations are as follow:—*First, when the flame is of constant height, and the distance of the disc from the tube is varied,* the difference of potential required to produce the spark is greater when the disc is negatively electrified than when it is positively electrified, excepting that for small distances there may be equality, or even a small difference the other way. Again, the difference of potential at the smaller distances is greater for the non-luminous flame than for the luminous; but at the greater distances it is very much the other way, particularly in the case of the negative charge. The range of distance extended to eight centimetres. There are differences in the behaviour of the flame co-existing with these differences in electromotive force. *Second, when the distance of the tube from the disc is kept constant and the weight of the flame varied,* the difference of potential required for the spark remains nearly constant when the flame is non-luminous, and also when the flame is luminous and the disc positively electrified. In the remaining case where the flame is luminous and the electrification negative, the difference of potential is at first very great, and it diminishes rapidly as the height of the flame is increased, until the flame is of sufficient height to reach over to the disc. Thereafter it remains nearly constant; though the flame be attracted so as to be in contact with the disc, the discharge still passes in the form of a spark.

* Abstract of Paper read before the Royal Society of Edinburgh, 6th March, 1882.

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CURATIVE ELECTRICITY.

It has been said of modern journalism by ill-natured critics that its attraction for the multitude consists in its being ignorantly entertaining—or, to put it differently, that the art of writing learnedly and at the same time pleasantly is practised with most success by people who have no exact knowledge. Whosoever would be an accomplished leader writer before all things it is necessary he know nothing, or next to nothing, of the subject upon which he discourseth—otherwise he will write a treatise, and will perish everlastingly. Such, say his detractors, is the *Quicunque vult* of the journalist; and, like most creeds, this of the newspaper oracle has probably something to say for itself. But with that we are not here concerned. Our own confession of faith just now, if it differ in nothing else differs in this, that we do not attempt to disguise it. The subject forced upon us by circumstances for comment in this article is one that we do not at all understand. Of curative electricity and curative magnetism we are profoundly ignorant, and are, presumably, in the highest degree qualified to write about them. If, therefore, we fail to be edifying on the present occasion, our failure must be set down to excess of candour—one characteristic of the popular leader being its pretentiousness, seeming to know what he does not know being as essential to the ideal leader-writer as to the real quack-doctor.

The offensive epithet we have just now made use of is by no means aimed at the professors of curative electricity, or even of curative magnetism. We are led to employ it simply because it was flung about pretty freely the other evening when these subjects were being discussed at the Society of Telegraph Engineers and of Electricians. Too freely, it seems to us, for to begin by describing as quackery that which you are about to discuss as genuine is to beg the main question, and render discussion altogether useless or absurd. The stigma under which the empirics above referred to may be supposed to labour in an assembly of trained scientists probably silenced them for the occasion; but it seems to us they have a somewhat disagreeable retort ready to hand for their learned critics: If there is nothing at all in what we pretend to practise, why are you here to discuss it? To the recognised surgeons of a public hospital you proffer all the help in your power, although they are only just beginning to do what we have been doing for many years; whilst upon us you cast the opprobrium of quackery and charlatanism. This we can readily imagine the unrecognised practitioners saying to each other; and if they are honest men they will say it bitterly. Had the occasion we are referring to been one avowedly devoted to the exposure of imposture, the case would have been different. Nothing of the kind was contemplated, however, or attempted. On the contrary, much deliberate consideration was given to the very phenomena upon which the common advertiser chiefly insists; and although the evidence was of the meagrest description, so far as it went it favoured the "quacks," though of course their nomenclature and their diagnoses were all at sea. We may quarrel with the looseness of their language, but until we can impeach their facts we have no right to impugn their character.

We by no means assert that the alleged facts cannot be gainsaid; we simply do not know; but this we do know from everyday experience of the world that imposture thrives as much on the contempt of the learned as on the credulity of the unlearned. Expose it, denounce it, or else confirm and direct it. To let it alone may be easiest; but there is nothing virtuous in an attitude of *laissez faire*, nothing that entitles us to ascend a pedestal from which to declaim against the folly and fraud of mankind.

For these reasons we are glad that men of good repute are now conscientiously investigating this very obscure subject, though we cannot congratulate them on the result of a discussion somewhat prematurely brought on. The public will be gainers in any case. If electricity have any curative properties we shall learn what they are; if there are none, then we can make bold to say so in public hearing.

Meantime it may be said for the vendors of pads, brushes, chains, belts, slippers, rubbers, and all the array of electrical and magnetic paraphernalia, that if they do not cure they probably do not kill. That electricity is capable of killing, however, is no doubt one good reason in the minds of some people why it may also be able to cure. This much, or this little, may be said of most medicines. A jorum of rhubarb is unpleasant, so is an electric shock. Their respective effects are undeniable; both inflict a certain amount of pain, its intensity depending on the doses. Hence it is argued that good or harm must result, good if only we knew how and in what quantity to administer them. The inference is natural, but not conclusive. A knock with a stick will rival any ordinary voltaic shock, and "pins and needles" are no bad imitation of induced currents. But neither external bruising nor interrupted circulation has ever yet been thought beneficial; and it is precisely this question of benefit which the doctors have yet to determine for us. We cannot determine it for ourselves; patients are notoriously untrustworthy, easily believing what they wish to be true, especially when their faith has been backed with hard cash. In hospital practice this element of self-deception will be absent, a circumstance all in favour of the doctors.

Of curative magnetism we have left ourselves very little

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room to speak; but except that it is not so energetic in its action as electricity, the line of argument for and against the use of either hold equally good for both. Magnetism does not hurt, but its effect on material bodies is even more easily shown than that of electricity. Besides, it dates from remote antiquity and has a highly respectable pedigree. The Chinese discovered the magnet, and being a pre-eminently practical people they tried its active properties for the cure of physical ailments. Pulverised loadstone was conceivably good for something, and whatever that something might be we are just as ready to believe in its cure by magnetic pilules internally taken as by magnetic bands externally applied. All these nostrums and appliances alike want taking out of the atmosphere of occult mystery which has so long surrounded them, and when next we have to write about them, we shall be glad if, thanks to Drs. Stone and Kilner, we are able to understand our subject a little better.

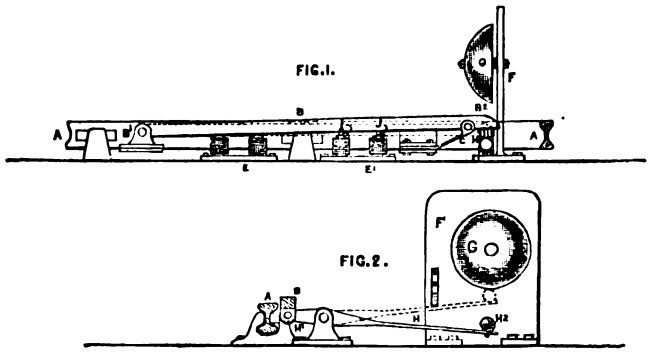
CRYSTAL PALACE EXHIBITION.

Miscellaneous Exhibits.

Sullivan's Electric Railway Fog Signal.

This method of signalling is especially designed for use in foggy weather, and at other times when the ordinary visible signals cannot be readily seen.

The apparatus will be best understood by reference to the accompanying illustrations. Fig. 1 is a side elevation of the complete apparatus; Fig. 2 is an end view of the same. A is the ordinary rail, and B the side rail or bar of soft iron, which is placed on the outside of the track, and pivoted at the lowest end B^1 to the side of the ordinary rail. At the leading end B^2 it is held in position by the spring C. E and E^1 are powerful electro-magnets for drawing down the bar B below the top of the rail when desired. F is the framework for carrying the gong G. H is the striking lever jointed to bar B at H^1.



Sullivan's Railway Fog Signal.

The passing wheel depresses the side rail or bar B, and thereby forces down the short end of the striking lever H, raising the head H^2, and sounding the gong G.

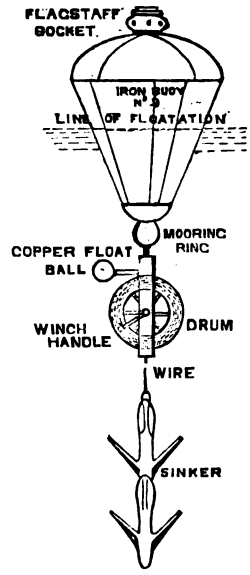
If the side rail be made long enough the first wheel will not get clear until another is upon it, in which case the gong will only be sounded once for each train or single engine passing, but if the side rail be made short enough it will give a separate blow for every wheel on that side of the engine or train. The side rail remains raised so long as the ordinary signal with which it works in conjunction is at danger, but when the line is clear and the signalman places his signals in position indicating line clear, in the act of so placing them he causes an electric current to pass through the magnets E E^1, which magnets then draw down the bar B below the top of the rail, so that if a train then passes, no audible signal being given, drivers would know they could safely proceed, although unable to see the ordinary signals.

The audible signals would be placed within stopping distance in advance of the visible signals. I and J are two projections on the bar B, which pass into hollows made for their reception in the poles of the magnet E^1. By this arrangement the distance between the magnet and the bar, even when raised above the rail, is very small.

Johnson and Phillips' Mark Buoy.

An ingenious and convenient little mark buoy, for use in marking positions during cable operations, has been designed by Messrs. Johnson and Phillips, and is exhibited in the western gallery of the Exhibition. Its advantage over other mark buoys is that it requires very little time to place it, as it moors itself, and the cost is not great owing to the substitution of wire for mooring chains.

The buoy, which is illustrated in the figure, is suspended over the water by a line made fast at any convenient projection on the stern or quarter of the ship, so that when the line is cut through the buoy will drop into the water clear of the ship's side.



Johnson and Phillips' Cable Mark Buoy.

On dropping the buoy the copper float ball attached to the drum of steel pianoforte wire is raised by the water, and thereby operates a detent which releases the drum and allows it to revolve. The drum then pays out the whole length of the wire, which ought to be considerably in excess of the depth of water at that part. A winch handle is provided for the purpose of recovering the mooring wire and anchor, if need be, by winding up the drum; but the cost of a sink, anchor, and mooring wire is so little that, as a rule, it will hardly pay to waste time in recovering it. Several drums containing lengths of wire suitable for different depths are provided, and these can readily be placed in the drum frames. The cost of sinker and 1,000 fathoms of wire does not exceed 20s.

Insulated Wire for Electric Light Purposes.

The success of the telegraph and the telephone is due in no small degree to the wire drawers, and to those who cover the wire with insulating material. Faulty insulation in cable work, as is well known, is ruinous, and the system of perfectly covering wire has become a well developed art. In the Exhibition several well-known firms show their specialities. The Telegraph Construction and Maintenance Company show specimens of their cables in the nave, and specimens of insulated wire in the gallery, but of cable work we shall say more hereafter. For electric light purposes Messrs. Phillips Bros., and Messrs. Glover have stands in the gallery. It is again exceedingly difficult to distinguish between the exhibits of the one firm and the other. To outward appearance many of the coils are alike, but Messrs. Phillips Bros. have the largest and best assorted array of wire for electric light purposes that is shown. We can speak somewhat from experience about the insulated wire of this firm, as we have recently used some for the interior work in connecting incandescent lamps, and we have found the

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wire supplied quite equal to any demand that should be made upon it. Neither Messrs. Phillips nor Messrs. Glover, however, restrict themselves to show wire for one purpose only. They show telephonic wire, which might almost be said to come under the head of wire for electric light purposes, as much of it is used in connection with incandescent lamps. We would call special attention to the compound "leads" of Messrs. Phillips, as well as to the wire for internal work.

Johnson and Nephew's Exhibits.

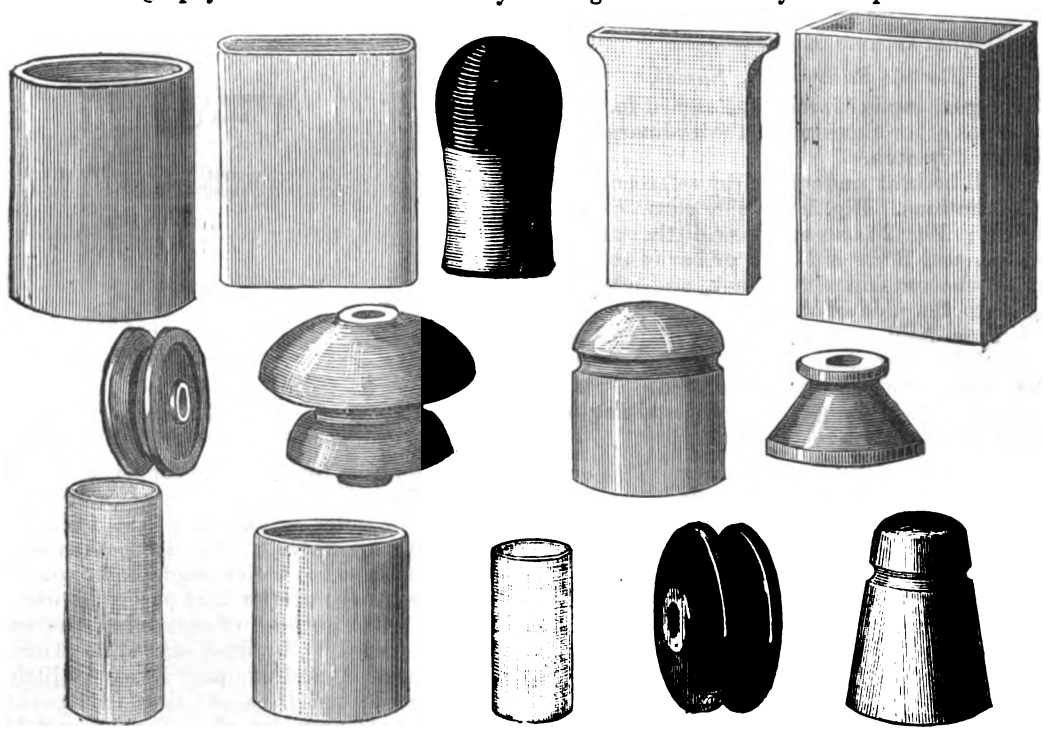
This firm shows 1 coil of No. 00 B.W.G. galvanised cable armour; weight, 308lb., or 140 kilos. 1 coil of No. 8 B.W.G. galvanised telegraph wire of low electrical resistance; weight, 4cwt., or 204 kilos; length, 2,036 yards, ·171in. dia.; breaking strain, 1,050lb., 21 twists in 6in.; resistance, 11·25 ohms. 1 coil of No. 11 B.W.G. galvanised special telephone wire; weight, 140lb., or 63 kilos.; length, 1,220 yards. 1 coil of No. 15 B.W.G. galvanised special telephone wire; weight, 140lb., or 63 kilos.; length, 3,645 yards. 1 coil of No. 16 × 3 ply galvanised telegraph strand. All the above pieces are rolled in one continuous length.

J. Stiff and Sons' Exhibits.

The requirements of telegraphy from the workers in clay are by no means unimportant, although it may be the excellent exhibits of Bourne, Doulton, Stiff, &c., will receive less attention than they ought in the all prevailing anxiety to see the electric light. The near future may, however, show that glazed earthenware pipes may be found very suitable for insulating electric light leads, and no doubt the various makers have or will turn their thoughts to the specialities of this case. We are sure, however, that the casual observer must allow that the makers of "porous jars," of insulators, of "acid pans," &c., have run each other a close race, and without a long series of delicate experiments it would be difficulty to give a prize for excellence of manufacture to any special firm. We have no preference, and it is purely accidental that the one or the other exhibit is described first. Messrs. Stiff, then, exhibit porous cylinders of all sizes in red and white ware, and of various degrees of hardness to suit the special requirements of purchasers; also flat porous plates about 5in. square, and larger sizes up to 12in. or 15in. square. Some of their porous cylinders and plates are glazed on the upper edges. They also send flat porous linings in red and white ware in a variety of sizes. They exhibit vitrified stoneware battery jars, both round and square, in brown and white stoneware. Their stoneware insulators are thoroughly vitrified, and are made in all the usual shapes and sizes. They exhibit models of condensing coils, receivers, retorts, stills, dip arms, acid pans, and all kinds of stoneware chemical apparatus specially suited for electrical and telegraphic purposes; also plumbago and fire-clay crucibles. The accompanying illustrations show some of the different shapes in which the porous jars, insulators, &c., are made.

Bourne and Son's Exhibits.

This firm exhibits stoneware insulators and battery cells. The special characteristics of these insulators and cells are a high degree of vitrefaction, combined with great toughness and strength—qualities which, since the introduction of the manufacture upwards of thirty years ago, have led to a very large and increasing demand. The specimens include several patented shapes, which the firm has enjoyed the exclusive right to manufacture. Amongst these may be specially noted Mr. Varley's patent double V in several sizes. These and the well-known Z patterns have for many years been supplied in large quantities to the Postal Telegraph Department, as well as to the leading railway companies of Great Britain. Many of the larger exhibits are copies of the designs of foreign and colonial engineers, who look for strength and durability under peculiar circumstances, as well as perfect insulation for long distances. The same qualities enter into the composition of the vitreous battery cells, and the articles, as a whole, may be said to combine all the excellencies of the most expensive porcelain with greater strength and durability, and at less cost.



Stiff's Porous Jars, Insulators, &c.

Rogers's Needle Sounder.

The illustration shows the needle sounder patented by Mr. F. M. Rogers, and shown at the Crystal Palace. Transmission, or rather reception, by means of a sounder, though first introduced in America, is becoming quite common in England. In the instrument shown the needle is caused to reproduce the direction of its beat in sound. A wire is led from the small local battery A to the terminal B, which is in connection with the post and rubbing contact B 1, and thus the needle C is put into contact with it through the dial plate D, and the bridge E. The ivory pins used to restrain the play of the needle are removed and replaced by platinum, F F; these being soldered to thin brass strips carefully insulated from the dial plate by ebonite, but in metallic contact with the segments G, and through the rubbing contacts H with the sounder or sounders I, the return wires from which are led to the battery. It will be seen that the needle becomes a

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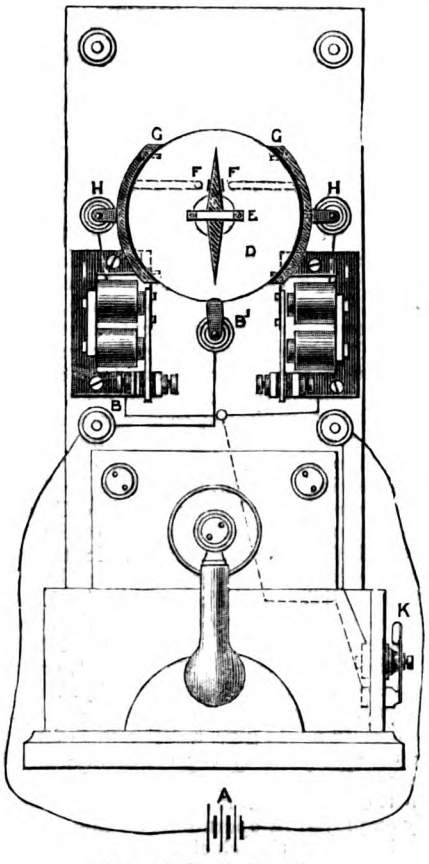
vibrating key, and that when it strikes the pins a current passes, and causes the sounder nearest the pin to speak, each sounder having a different note. If only one sounder be used, the interval needful for reading the Morse code can be produced by the drop handle or tapper as easily as by the key. When desired, the sounder can be replaced by a single stroke

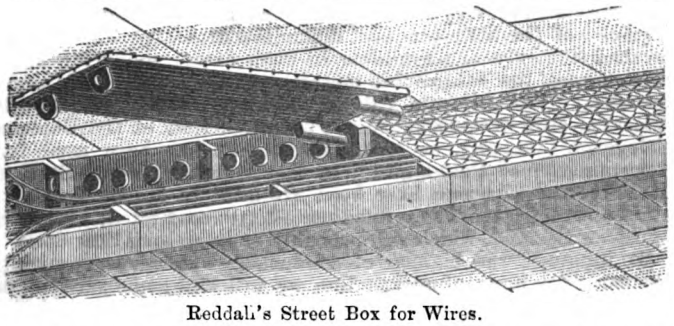


Rogers' Needle Sounder.

or trembling bell, the pegs being connected so as to cause it to ring when the needle strikes against either pin. Either sounder or bell can be cut out by the switch K, and if desired either can be separated from the instrument, and placed in any convenient position.

Street Box for Wires, &c.

Among the many ingenious contrivances of a practical character now being shown at the Crystal Palace may be



Reddall's Street Box for Wires.

mentioned Reddall's street box. This box is intended to be of iron, though the models shown are of wood. Our illustration shows the idea of the designer better than any lengthy description. The method of fastening is simple and effective. It will be seen that if such a system were adopted the box could be used instead of the existing curb, and it would be easy at any time to lay or repair wires. The model is in the gallery, near to the Portrait Saloon.

Davis and Timmins' Exhibits.

One of the neatest and best-arranged exhibits is to be seen at the stand of Messrs. Davis and Timmins, in the gallery, almost immediately under the big clock. It is difficult to be very enthusiastic over binding screws, and such like modest things, which, however necessary in electrical work, do not appeal much to the imagination. The various steel, iron, and brass requisites of the electrician are made by this firm, and the samples they exhibit seem beautifully finished, and appeal to the onlooker as models of good workmanship.

Electro-Plating Apparatus.

There are many small articles which the householder would like plated, but which are too trifling to send to a professional plater, and for such simple work this apparatus is useful. It may also be found useful in schools, &c., for class demonstration. The construction of the apparatus is simple, the bath and battery being in the same case. The electromotive force is under four volts, and the plates having great surface, a considerable quantity of current is obtained. In many cases nickel is plated with too high an electromotive force, the result being that the nickel is very easily chipped off. No acids are used ; the zincs do not require amalgamation, and the battery is said to be *fairly constant*. The apparatus is shown on the stands of Messrs. Dale and Co., and of Messrs. J. Orme and Co.

LONGITUDE BY TELEGRAPH.

A large quarto volume has recently been published by authority of the Lords Commissioners of Her Majesty's Treasury, containing an account of the work of the British Expedition for observation of the Transit of Venus across the Sun in the year 1874, undertaken for determination of the distance of the earth from the sun.* One important operation in connection therewith, of which a detailed account appears in the volume in question, was the determination of the longitude of Cairo by use of the submarine lines of the Eastern Telegraph Company, an operation well illustrating the aid which telegraphs can give in the furtherance of scientific work.

The appearance of this volume forms a favourable opportunity for drawing attention to the general subject of the employment of the telegraph in longitude work, in order to show in what cases its use is valuable, and also the special advantages to be derived from its employment therein.

First, as to the nature of the problem. The position of any place on the earth is fixed by means of its two co-ordinates of latitude and longitude. The latitude of a place, that is its distance from the equator north or south, can by astronomical observation be readily and accurately determined. But its longitude, which is the distance of its meridian east or west of the meridian passing through some particular place taken as standard, as, for instance, Greenwich, is by no means so easily found.

By the uniform revolution of the earth on its axis every portion of its surface is successively turned to the sun once in twenty-four hours, and, since the apparent motion of the sun in the heavens is from east to west, it will be seen that noon will occur at places east of Greenwich earlier than at Greenwich, and at places west of Greenwich later than at Greenwich, that is to say, if the clock at each place be adjusted to local solar time, that at a place to the east of Greenwich will be constantly fast of that at Greenwich, and that at a place to the west of Greenwich constantly slow of that at Greenwich. The difference in either case is the longitude of the given place from Greenwich. Generally, therefore, difference of longitude between two places is simply the difference of their local times, both reckoned in solar time, or both in sidereal time, as may be convenient. So that, if the clock at one station could be transported to and compared with that at another station, the difference of longitude between them would be at once exactly known. Or could direct communication, as by telegraph signal, be established, the longitude would similarly become, with equal exactness, known. The advantage of telegraphic communication is thus apparent, although, in order properly to realise its extreme value, it may be desirable to give some little account of the means previously available for determination of the longitude problem.

It will have been gathered that the problem generally consists of two distinct parts, one the finding of the local time at the given place—not a formidable operation—the other the discovery of the equivalent Greenwich time, hitherto the really difficult part of the problem, and for which it was formerly necessary to

* "Account of Observations of the Transit of Venus, 1874, December 8, made under the authority of the British Government, and of the Reduction of the Observations." Edited by Sir George Biddell Airy, K.C.B., Astronomer Royal.

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depend almost entirely upon observations of the moon, as we will endeavour briefly to explain.

The most casual observer may remark that the moon, from night to night, shifts rapidly her position amongst the stars. Now the stars may be likened to the figures on a clock dial, and the moon to the pointer, moving amongst them, and continually indicating the time, in such way that, if the Greenwich times at which the moon would occupy definite positions could be beforehand known, observation of her position at any part of the globe would give the means of finding the Greenwich time. When it was desired practically to apply this principle, it was found that neither were the positions of the stars sufficiently well-known, nor were the existing tables of the very complex motion of the moon at all exact enough for such a purpose, and it was to obtain as perfect a knowledge as possible on these points that, two centuries ago, the Royal Observatory at Greenwich was founded, entirely in the interests of navigation. Continuous observation throughout the period since elapsed has so much improved our astronomical knowledge, that the "Nautical Almanac" of the present day (that for the year 1767 being the first published) now gives abundant and accurate information in regard to the daily position of the moon as referred to Greenwich time. So that generally, if at any place her position in the heavens be determined at a definite local time, the "Nautical Almanac" gives the means of inferring (after the application of some small corrections known in the method used by sailors as the "clearing of the lunar distance") the corresponding Greenwich time, and hence the longitude. This was, and indeed still is, the only thoroughly general method of ascertaining the longitude, and on it, in one shape or other, both navigators and astronomers in times past had principally to rely. There are other astronomical phenomena occasionally available for longitude purposes, but not occurring with sufficient frequency to be of any great practical use.

As regards navigation, astronomical methods of finding the Greenwich time have, since the great improvement in the chronometer, been practically given up. For, by its means, the navigator may now carry about with him Greenwich time sufficiently accurate for all his wants, instead of laboriously reading it off from the face of the sky by observation of the moon. So that, having ascertained his local time, he is at once able to determine his longitude. The telegraphic method is not applicable by the navigator, and even if it were, its use would be an unnecessary refinement, since, by the carrying of two or three chronometers, he obtains all required accuracy. In fact, in cloudy weather, he may by his chronometers know the Greenwich time much better than, continually shifting his position as he does on the sea, he knows his own local time.

The chronometer method of determining longitude became in later times frequently used also by astronomers for ascertaining better the relative positions of fixed observatories. In such cases a large number of chronometers would be employed, and frequent journeys between the two places whose difference of longitude was to be determined would be made. The method, as thus used, is an exceedingly accurate one, giving results superior to those obtained by the lunar method, but its practical application for very accurate work is limited, since its value depends entirely upon the accurate performance of the chronometers, and consequently upon the rapidity with which they can be carried from one place to the other. Though not generally available for long distances, the method has been used to determine the longitude of Cambridge, U.S., from Liverpool, by sending chronometers across the Atlantic, and other determinations also involving long journeys have been made. Under very favourable conditions the method is capable of giving results equalling those obtained by use of the telegraph; but how the possession of telegraphic communication, especially between places widely separated, would supersede the tedious and troublesome transmission backwards and forwards of a large number of chronometers will be at once seen.

Before the introduction of the electric telegraph the state of the longitude problem, as regards fixed observatories, was this. Although, for places not widely separated, differences of longitude could be determined by the chronometric method with exceeding accuracy, in very long journeys the accumulation of errors in the chronometers would introduce such uncertainty, not to speak of the difficulty of transport, that, for many places, it was still necessary to depend upon the lunar method in some shape or other. The question may, however, be reasonably asked, if the "Nautical Almanac" positions of the heavenly bodies are now so accurate, why does not the lunar method still abundantly suffice? For the reason that, although when every precaution is used, and when numbers of observations have been made, it is possible to arrive, by this method, at a fairly accurate longitude, such exactness as modern astronomical science desires, and which the telegraphic method readily gives, cannot, on account of certain small practical difficulties not necessary here to further specify, be obtained, even after many years' observations.

In this state of things the electric telegraph, some thirty years ago, became an accomplished fact, and it was soon perceived that its extension might render valuable aid in two ways probably not contemplated by those to whose energy its establishment was due. These were, the daily distribution of accurate time, and the determination of differences of longitude. When, somewhat later, the proposal for laying a submarine cable across the English Channel was carried to a successful termination, the result was viewed with lively interest by scientific men, both in England and on the Continent, and in the year 1853 the first European determination of longitude by electric telegraph was made, the channel line having been in that year used to determine the longitude of Brussels from Greenwich, and in the year following that of Paris, after which period the telegraph became in this way frequently applied.

It has been explained that the difficulty of the longitude problem consists essentially in the determination at any place of the corresponding Greenwich time, in order that the difference of times, which is the difference of longitude, may be obtained. Of course in all cases in which application of the electric telegraph is possible this difficulty altogether vanishes. For, by extending each end of the telegraph line to the respective observatory clocks, and placing in circuit near each clock a signalling key and some kind of indicator, each operator may, at certain pre-arranged times, signal the beats of his own clock to the operator at the other station. The times of such signals being noted at the receiving station, the difference between the two clocks becomes immediately known, which difference, when corrected for the errors of the clocks, each on its own local time, gives at once the difference of longitude. In the course of a few hours many hundreds of signals may be passed through the line, and a very accurate difference of clocks obtained. It is important that signals be given from both ends of the line, for, if sent from one end only, the times noted at the other end being constantly late, owing to the retardation of the current, or wave time, the longitude measured would be affected thereby. This quantity is in general very small, but yet is one not to be neglected. The signals passed in one direction will give a difference of longitude which is too great; those passed in the other direction will give one which is correspondingly small; the mean of the two values will be free from the effect of retardation. Chronographs are now very generally employed in operations of this kind, one at each station. The beats of the clocks of both stations are then simultaneously recorded, first on the chronograph of one station, then on that of the other station. Each chronograph will furnish a difference of longitude, one of which will be increased by the wave and armature time, and the other diminished; the mean value, as before, will be free from these effects.

When the circuit includes little subterranean or submarine line the exchange of signals is a very simple matter, but when long submarine lines are used the operation is not quite so easy. For since the current at the end of such a line only slowly manifests itself, the desired sharpness of signal is wanting. Still, no sooner were such lines established than astronomers became anxious to employ them, since the telegraphic determination of the longitudes of very distant points had a special value, in consequence of the little practical difficulties attaching to the lunar method (the only one available in such cases) rendering such accuracy as the telegraphic method can give altogether unattainable. The Atlantic cables, both to North and South America, have frequently been thus used, that of the Eastern Telegraph Company, as before mentioned, has been used for determination of the longitude of the Transit of Venus Station at Cairo, and measures have been extended to Aden, Bombay, and South Africa. There remains to be yet connected, Australia and New Zealand, which will probably be in no long time done.

To illustrate the manner of conducting operations requiring the use of a long submarine line we will add some particulars concerning the experiments undertaken for determination of the longitude of Cairo from Greenwich, as set forth in the volume to which we have drawn attention. When it became necessary to fix upon suitable positions for observation of the Transit of Venus in 1874, Egypt was one of the countries selected; and since a knowledge of the longitudes of the different stations at which it was proposed that the transit should be observed was a necessary factor in the problem, the question arose as to the best means of determining them. As regards those of points in Egypt, the authorities of the Eastern Telegraph Company at once freely offered the use of their submarine lines, extending from Porthcurnow, in Cornwall, to Alexandria. The communication with Alexandria is by five distinct cables. 1. Porthcurnow to Vigo, 2. Vigo to Lisbon, 3. Lisbon to Gibraltar, 4. Gibraltar to Malta, 5. Malta to Alexandria. In the ordinary use of the cables for speaking, messages are repeated successively over each

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section, but for the longitude work it was essential that the five sections should be joined up into one continuous cable, connecting Porthcurnow directly with Alexandria, without instrument of any kind in circuit. Some doubt having been expressed as to whether effective signals could be passed through such a length of line, certain preliminary experiments were made which showed that this was quite feasible. And since no connection of a land line with a submarine line is allowable, the scheme of operations was as follows. Time being determined at the Royal Observatory at Greenwich by astronomical observation, signals were exchanged with an observer stationed with chronometers at Porthcurnow. The Porthcurnow observer exchanged signals through the whole length of submarine line with an observer stationed at Alexandria, and similarly provided with chronometers. The Alexandria observer then finally exchanged signals with the observer at Cairo, and time being determined at Cairo, the operation was complete. Porthcurnow and Alexandria were thus simply transmitting stations. On four nights in November, of the year 1874, this programme was, thanks to the care and attention given by the officers of the Company, most successfully carried out. There was nothing peculiar in the giving or receiving signals on the land sections, or in giving signals on the cable. Those received on the cable were made visible by attaching a small mirror to the coil of a Thomson syphon recorder, two methods of observing the beam of light being employed—I., in which the first start of the beam from rest was the phase of signal observed; and II., in which the time of transit of the beam over the middle point of its complete excursion was the phase noted, the latter method having been proposed by Mr. C. F. Varley. The gradual rise in strength of the current, as thus received at the end of a long submarine line, rendered it difficult to catch, in the first-mentioned method of observing, the exact start of the beam from rest, but since the signal was received precisely in the same way at both ends of the line, any injurious effect on the result was practically eliminated.

And now as to the results. The nights of experiment and separate values of longitude obtained were as follow:—

LONGITUDE OF CAIRO FROM GREENWICH.

	Method of receiving Cable Signals.	
	I.	II.
1874.	H. M. S.	H. M. S.
November 14	2 5 6·54	2 5 6·50
,, 15	6·57	6·71
,, 21	6·56	6·67
,, 22	6·48	6·64
Means	2 5 6·54	2 5 6·63

The two different methods of observing signals received on the cable thus give very nearly the same result. It may be pointed out that there is also involved, in the separate results, any inaccuracy in the time determination, on any one of the nights, either at Greenwich or Cairo, as well as any error in the exchange of signals on either of the three separate sections of wire, and yet the extreme difference of the eight individual values, from all causes combined, is under one quarter of a second of time, the two mean values agreeing within the tenth part of a second, equivalent to a distance of some thirty yards only on the earth's surface. And the whole operation was completed on four nights. Especially is the telegraphic method important for the determination of longitudes between places thus widely separated, since equal certainty and exactness cannot at present be arrived at in any other way, not to speak of the readiness of the method as compared with the extreme labour and tediousness of all others. The mean result, 2h. 5m. 6·58s., requires still correction for small differences in the methods of the observers in giving and receiving signals, and in determining time at the two ends of the line. These being applied, the deduced longitude of the Cairo Transit of Venus Station is found to be 2h. 5m. 6·24s. east of Greenwich, which is the final value as it appears at page 288 of the printed volume.

The retardation of the current on the cable, or rather the interval which elapsed between making contact at one end of the cable and the sensible perception of the current at the other end, was found to be 1·3s.

The determination of longitude by electric telegraph is, from the nature of the operation, necessarily capable of great exactness, since it is practically equivalent to transporting the clock of one station to that of another, and making comparison directly between them. Longitudes of points supposed to have been previously well known have required unexpected correction. Thus, on determining the longitude of Paris by the telegraphic method it was found that the hitherto-accepted value was about one second of time in error, and, more recently, Lieutenant-Commander Green, of the United States Navy, in carrying out an extensive series of telegraphic determinations of longitude, found that the previously-received value of the longitude of Lisbon was no less than eight seconds of time in error. There can be no manner of doubt in regard to these corrections, the certainty of the method by telegraph being one of its prime advantages.

Before concluding our remarks there is one thing which, from the point of view of the astronomer, should on no account be omitted, and that is acknowledgment of his indebtedness to the various telegraphic authorities, both public and private, and especially to those having the command of long submarine cables, for the way in which they have ever shown themselves ready to aid in the carrying out of operations such as those to which we have here drawn attention. Not only at such times has the use of the necessary connecting lines been gratuitously given, but the members of the telegraphic staff have, in addition, frequently shown a more than kindly endeavour to promote in every way the success of the work.

That other use of the electric telegraph to which allusion has been made, its employment for the distribution of accurate time, is a subject of interest as well to the maritime as to the commercial world, but our remarks on its application to the determination of longitude have extended to such a length that we cannot here enter further into the closely-related subject of time distribution.

THE CHEMISTRY OF THE PLANTE AND FAURE ACCUMULATORS.*

BY J. H. GLADSTONE AND ALFRED TRIBE.

PART I.—*Local Action.*

Among the important discoveries of late years few have claimed so much attention, or have been so full of promise for practical use, as the accumulator of Planté and its modifications. Our attention was very naturally directed to the chemical changes that take place in these batteries, especially as it appeared to us that there must be certain analogies between them and some actions which we had previously investigated. In the present communication we propose to treat merely of one point—that of local action, leaving the fuller discussion of the subject to some future occasion.

It is well known that metallic zinc will not decompose water, even at 100°C., but we found that zinc on which copper had been deposited in a spongy condition was capable of splitting up the molecule even at the ordinary temperature, oxide of zinc being formed and hydrogen liberated. If placed in dilute sulphuric acid, it started a very violent chemical action, sulphate of zinc and hydrogen gas being the result. We termed the two metals thus conjoined the *copper-zinc couple*, and this agent was fruitful in our hands in bringing about other chemical changes which neither metal singly would effect. Electricians will readily understand the nature of this agent, and will recognise in its effects only a magnified form of what we are all familiar with under the name of *local action*. Now, the negative plate of a Planté secondary battery is a sheet of lead, upon which finely-divided peroxide of lead is distributed. It is well known that the electromotive force of lead and lead peroxide in dilute sulphuric acid is nearly three times that of zinc and copper in the same liquid. We were, therefore, induced to think that the plate must act in the same way as our copper-zinc couple. We found such to be the case. If a plate so prepared be immersed in pure water the decomposition of the liquid manifests itself by the reduction of the puce-coloured peroxide to the yellow monoxide. There could be little doubt, therefore, that the lead peroxide couple, if we may call it so, would decompose sulphuric acid with the production of sulphate of lead. This also was found to be the case.

As the destruction of peroxide of lead means so much diminution of the amount of electric energy, it became interesting to obtain some definite knowledge as to the rapidity or extent of this action.

When the peroxide of lead on the metal is very small in quantity, its transformation into the white sulphate goes on perceptibly to the eye, but when the coating is thicker the time required is, as might be expected, too long for this kind of observation. In one experiment, following the procedure of Planté, we formed the peroxide on the plate by a series of seventeen charges and discharges, or reversals, each operation lasting twenty minutes, and the time was further broken up by seven periods of repose, averaging about 24 hours in length. After the last charge we watched the local action taking place, and found that the whole of the peroxide passed into white sulphate within 17 hours. In another experiment the two plates formed according to Planté's method were immediately joined up with the galvanometer and the deflection noted. They were then at once disconnected. After the repose of one hour they were joined up again, and another observation taken with the galvanometer. This was repeated several times, with the following results:—

Initial strength of current	100
After 1 hour's repose	97
,, 2 ,, ,, ...	40
,, 4 ,, ,, ...	14
,, 17 ,, ,, ...	1·5

It results from this that during each of the long periods of repose recommended by Planté the peroxide on the lead plate is wholly, or almost wholly, destroyed by local action, with the formation of a proportionate amount of sulphate. But this is not, as it would seem at first sight, a useless procedure; for, in the next stage, the sulphate is reduced by electrolytic hydrogen, and, by a process which we hope to explain when discussing the complete history of the reaction, the amount of finely-divided lead capable of being peroxidised is increased. That this is actually the case is shown by the following experiment. The peroxide formed on a lead plate by first charging was determined and called unity; it was allowed to

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remain in a state of repose for eighteen hours, charged a second time, the peroxide again determined, and so on:—

Separate Periods of Repose.	Charge.	Amount of Peroxide.
—	First	1·0
18 hours	Second	1·57
2 days	Third	1·71
4 ,,	Fourth	2·14
2 ,,	Fifth	2·43

In other trials, following the procedure of Faure, we employed plates in which the peroxide was formed by the reduction of a layer of red lead (containing 51 grains to one square inch of metallic surface), and subsequently completely peroxidising the spongy metal so produced. In one series of experiments we left the peroxidised plates to themselves for various periods and determined the amount of sulphate formed. This gave us the amount of peroxide consumed:—

Experiment	I.	after 2 hours	7·2	per cent.
,,	II.	,, 3 ,,	15·1	,,
,,	III.	,, 4 ,,	19·8	,,
,,	IV.	,, 5 ,,	30·0	,,
,,	V.	,, 24 ,,	36·3	,,
,,	VI.	,, 7 days	58·3	,,
,,	VII.	,, 11 ,,	67·3	,,
,,	VIII.	,, 12 ,,	74·3	,,

The last experiment was tested with the galvanometer during its continuance, as in the case of the plate formed by Planté's method, with the following results:—

Initial strength of current	100
After 1 day's repose	92
,, 3 ,, ,,	79
,, 4 ,, ,,	34
,, 5 ,, ,,	24
,, 7 ,, ,,	11
,, 9 ,, ,,	8
,, 12 ,, ,,	1

It is evident from these observations that a lead peroxide plate gradually loses its energy by local action, and that the rate varies according to the circumstances of its preparation.

Two difficulties will probably present themselves to anyone on first grasping the idea of this local action. 1. Why should a lead plate covered with the peroxide and immersed in dilute sulphuric acid, run down so slowly that it requires many hours, or even days, before its energy is so seriously reduced as to impair its value for practical purposes? In the case of the copper zinc couple immersed in the same acid, though the difference of potential is not so great, a similar amount of chemical change would take place in a few minutes. 2. In a Planté or Faure battery the mass of peroxide which is in contact with the metallic lead plate expands its energy slowly. How comes it to pass that if the same mass of peroxide be brought into connection through the first lead plate with another lead plate at a distance, it expends its energy through the greater length of sulphuric acid in a tenth or a hundredth part of the time?

The answer to these two questions is, doubtless, to be found in the formation of the insoluble sulphate of lead, which clogs up the interstices of the peroxide, and after a while forms an almost impermeable coating of high resistance between it and the first metallic plate.

The following conclusions seem warranted by the above observations:—

In the Planté or Faure battery local action necessarily takes place on the negative plate with the production of sulphate of lead.

The formation of this sulphate of lead is absolutely requisite in order that the charge should be retained for a sufficient time to be practically available.

The rapidity of loss during repose will depend upon the closeness of the sulphate of lead, and perhaps upon other mechanical conditions. These are, doubtless, susceptible of great modifications. We do not know how far they are modified in practice; but it is conceivable that still greater improvements may yet be made in this direction.

Part II.—*Preparation of the Cells.*

In *Nature* (vol. xxv., p. 221) we directed attention principally to the local action that takes place on the negative plate of a Planté or Faure battery. We pointed out the close analogy between zinc coated with spongy copper, and lead coated with spongy peroxide, in their action on water or dilute sulphuric acid; and we showed the importance of the lead sulphate produced in moderating this action. We now propose to treat of the chemical changes involved in the preparation of the cells.

The procedure of Planté in forming his battery is at first sight extremely simple. He takes two coils of lead, separated from one another, and immersed in dilute sulphuric acid; a current is sent through the liquid from one lead plate to the other, and the final result is, that the one becomes covered with a coating of lead peroxide, while hydrogen is given off against the other plate. On the view that the sulphuric acid merely serves to diminish the resistance, and so facilitate the electrolysis of water, the ready explanation would be given that the two elements of the water are simply separated at the two poles. But it seems more in accordance with the facts of electrolysis to suppose that the sulphuric acid, H_2SO_4, is itself the electrolyte, and that the oxygen results from a secondary chemical reaction. As a matter of fact, if water be employed, no peroxide is formed, but only the hydrated protoxide, even though a current from twenty-four Grove cells be made use of. The addition of a single drop of sulphuric acid to the water is enough to cause the immediate production of the puce-coloured oxide.

If we take two plates of lead in dilute sulphuric acid, and pass the current from only one Grove cell, a film of white sulphate, instead of peroxide, makes its appearance on the positive pole, and the action practically ceases very soon. If, however, the current be increased in strength, the sulphate disappears, and peroxide is found in its place. In Planté's procedure, spongy lead, and lead peroxide are, indeed, found on the respective plates. But, in consequence of the local action which takes place during the periods of repose, lead sulphate will be produced from the peroxide, and afterwards, in the course of the "formation," this must be reduced to metallic lead by the hydrogen.

It may seem at first sight improbable that an almost insoluble salt of the character of lead-sulphate should be decomposed under these circumstances. To test this fact by direct experiment, we covered two platinum plates with lead-sulphate, immersed them in dilute sulphuric acid, and sent a current through. We found not only that the sulphate was reduced by electrolytic hydrogen, but that it was peroxidised by electrolytic oxygen. The white sulphate was, in fact, decomposed to a large extent at each plate, the positive being covered with deep chocolate-coloured peroxide, the the negative with grey spongy lead.

The reaction which takes place in charging a Planté battery may be viewed in two ways. The simplest may be thus expressed in the notation which we have employed in some previous papers. For convenience, the reaction is divided into two stages:—

$$Pb_x \left| \begin{matrix} SO_4H_2 \\ SO_4H_2 \end{matrix} \right| Pb_y = Pb_{x-1} \left| PbO_2 \right| \begin{matrix} SO_3 \\ SO_3 \end{matrix} \left| \begin{matrix} H_2 \\ H_2 \end{matrix} \right| Pb_y,$$

and

$$2SO_3 + 2H_2O = 2H_2SO_4.$$

But it may be that lead-sulphate is always formed in the first instance, and decomposed on the continuation of the current.

$$Pb_x \mid SO_4H_2 \mid Pb_y = Pb_{x-1} \mid SO_4Pb \mid H_2 \mid Pb_y.$$

then

$$Pb_{x-1} \mid SO_4Pb \mid SO_4H_2 \mid Pb_y = Pb_{x-1} \mid PbO_2 \left| \begin{matrix} SO_3 \\ SO_3 \end{matrix} \right| H_2 \left| Pb_y, \right.$$

and

$$2SO_3 + 2H_2O = 2H_2SO_4.$$

It seems not improbable that both these reactions may take place according to the varying density, or other circumstances of the current. The coating of peroxide interposes a great difficulty in the way of the further oxidation of the metallic lead. Hence Planté needs the successive periods of repose, to admit by local action of the formation of lead-sulphate, and the oxidation of the increasing amounts of finely-divided lead thus brought into the field of action.

To obviate this waste of power and time, Faure covers both plates with red lead, and converts this into spongy peroxide and spongy lead respectively by the current. Now the first thing that happens when the plates are immersed in the dilute sulphuric acid is a purely chemical action. The minium suffers decomposition according to the formula—

$$Pb_3O_4 + 2H_2SO_4 = PbO_2 + 2PbSO_4 + 2H_2O.$$

But as both the lead sulphate and lead peroxide are insoluble, this takes place mainly at the surface, and requires time to penetrate. Thus in an experiment performed with the object of testing this point, the following amounts of minium were found to be converted into lead sulphate in successive periods of time.

Time.	Minium changed into sulphate.
15 minutes ...	11·8 per cent.
30 ,, ...	13·7 ,,
60 ,, ...	14·6 ,,
120 ,, ...	18·1 ,,

It might happen, and we are told it has happened, that the amount of minium employed has been great enough to abstract the sulphuric acid from solution, leaving only water. In that case water, of course, would be the electrolyte, and there can be little doubt that the lead plate would suffer oxidation in the manner which was described by us some years ago (*Chem. Soc. Journ.*, 1876) in a paper on "Phenomena Accompanying the Electrolysis of Water with Oxidisable Electrodes." This paper detailed the results obtained on passing a current from one Grove cell between two plates of the same metal immersed in pure water. We stated in the case of lead: "The positive electrode showed signs of slight oxidation, and the negative electrode a few small bubbles, in fifteen minutes; a slight cloudiness was then beginning to form, which afterwards increased; some oxide was found adhering in an hour; and afterwards grey metallic lead, which at the end of twenty-two hours was found to have stretched across to the positive electrode, forming a metallic connection which was so much heated by the passage of the voltaic current that the liquid became warm." We are informed that such lead crystals have sometimes been found in Faure's cells.

Supposing, however, that there is enough and to spare of sulphuric acid, the mixture of lead peroxide and lead sulphate presents a double problem. Were we dealing with peroxide alone, it would be reduced on the one plate at the expense of two molecules of water or sulphuric acid, while at the opposite pole the oxygen would simply be liberated.

$$Pb \mid PbO_2 \mid SO_4H_2 \mid SO_4H_2 \mid PbO_2 \mid Pb_y = Pb_x \mid PbO_2 \mid O_2 \mid SO_4H_2 \mid SO_4H_2 \mid Pb_{y+1}.$$

But as there is always lead sulphate present, this liberated oxygen is mainly used up in oxidating that substance, and it is evident from the following formula that it is theoretically sufficient to peroxidise the two molecules of sulphate—

$$2PbSO_4 + 2H_2O + O_2 = 2PbO_2 + 2H_2SO_4.$$

These two molecules of $PbSO_4$ are obtained from one molecule of Pb_3O_4 (red lead), and it appears that two atoms of oxygen are sufficient to transform this into peroxide. But the corresponding amount of hydrogen (four atoms) by no means suffices to reduce a similar amount of red lead on the other side, for in this case both the peroxide and the sulphate formed by the action of the acid have to be reduced. To accomplish this at least eight atoms of hydrogen will be necessary, and this will demand the electrolysis of an additional two molecules of water or sulphuric acid. It might, therefore, be expected, *a priori*, that the minium on the side to be oxidated ought to be twice the amount of that to be reduced.

In order to ascertain what is the real course of procedure in charging a Faure battery, we took two plates of lead of equal size, and covered each with a known weight of minium, which was almost pure Pb_3O_4. We passed a current of known strength, about one ampere, through the arrangement for many hours, noting the amount of hydrogen gas which was liberated at the one pole, and the amount of oxygen liberated at the other. From the data it was easy to calculate the amount of electrolytic hydrogen and oxygen utilised. We performed the experiment several times, varying the

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strength of the current and some other circumstances. The most complete result was as follows :—

Time.	Hydrogen.		Oxygen.	
	Lost.	Absorbed.	Lost.	Absorbed.
Hours.	c.c.	c.c.	c.c.	c.c.
1	Nil.	312	Nil.	156
2	,,	318	18	141
3	,,	306	48	105
4	,,	300	66	84
5	,,	300	72	78
6	2	313	90	67
7	5	295	87	63
8	3	312	96	61
9	6	303	93	61
10	21	297	99	60
11	37	273	99	56
12	101	220	105	56
13	150	158	105	49
14	195	132	105	58
15	210	92	100	51
16	228	90	106	53
17	225	85	100	55
18	270	66	108	60
19	264	51	108	49
20	270	50	111	49
21	273	43	114	44
22	270	30	114	36
23	276	30	114	39
24	297	21	123	36
25	309	9	126	33
26	270	18	120	24
27	300	18	132	27
28	309	11	138	22
29	321	15	141	27
30	318	15	147	19
31	300	6	135	18
	5,230	4,489	3,120	1,737

The amounts of hydrogen and oxygen capable of being absorbed by the materials on the plates were 4,574 and 1,294 respectively.

We read the indications of this table in the following way :—At first, both the reduction and oxidation take place very perfectly, with little loss of either of the elements of water. The absorption of the hydrogen proceeds with little diminution, until by far the greater part of the lead peroxide and sulphate are reduced, but the last portions are very slowly attacked, probably because they are imbedded in a mass of reduced lead. On the side that is being oxidated it is otherwise; a considerable waste of oxygen soon shows itself, but nevertheless a continuous slow absorption of that element takes place long after the theoretical amount of it has been fixed. A very small amount of this excess is to be attributed, according to our experiments, to the oxidation of the metallic plate itself. But we attribute the greater portion to the local action which must be constantly going on between the peroxide and the lead plate with the formation of sulphate of lead, the sulphate in its turn, of course, being attacked by the electrolytic oxygen. Thus the excess of oxygen in the fifth column of the above table may be looked on as a measure of the local action which has taken place during the charging, and the figures in the lower portion as roughly indicating its progress from hour to hour. Local action will, of course, take place at first on the opposite plate, but it requires no more hydrogen to reduce two molecules of lead sulphate than one molecule of lead peroxide, and the possibility of local action gradually diminishes as the reduction proceeds.

All our other experiments told the same story as far as the absorption of hydrogen is concerned, but there are differences on the other plate. In one or two instances, not half of the theoretical amount of oxygen was absorbed. On searching into the circumstances on which this depended, we were unable to arrive at any other conclusion than that it was connected with the condition of the surface of the lead plate.

Experiments with a current of about two amperes showed that a larger quantity of both hydrogen and oxygen was fixed in a given time, but there was a larger proportionate loss, especially in the case of oxygen. Experiments with a current of about half an ampere, on the contrary, gave a somewhat less rapid action, but a smaller waste of force through the escape of free gas.

Strength of current.	Amount of oxygen stored.	Time.	Loss of oxygen.
Ampères	c.c.	hours.	c.c.
2	300	1·5	174
1	,,	2	18
½	,,	3·8	15
2	600	4·1	617
1	,,	5·5	249
½	,,	7·6	47
2	1,000	13·9	3,081
1	,,	12·2	900
½	,,	16·0	400

A complete study of the results of these experiments would be instructive, but the comparisons given above may suffice to illustrate the points mentioned. The theoretical amount of oxygen required for the red lead used is about 1,200 cc., and the table shows the length of time in which 300, 600, and 1,000 cc. were fixed by different strengths of current, together with the accompanying loss.

In some cases we mixed the red lead with a little water, and allowed it to dry. In other experiments we mixed it at once with dilute sulphuric acid, but without any particular practical advantage.

The forming of a good secondary battery is a matter evidently depending upon very nice adjustment of conditions. It is but a few of these that we have carefully studied; nevertheless, we feel ourselves in a position to make one or two suggestions in regard to the economic aspects of the question. It is evident that the energy stored up in a cell is determined mainly by the amount of peroxide present. This appears to be obtained with the smallest amount of waste when the current is not too strong; in fact, in our experiments it was obtained when the density of the current was about 6½ amperes, calculated on the original surface of the lead plates.

There would seem to be no commensurate advantage in continuing the current after the oxygen has ceased to be absorbed pretty freely, because the presence of some unoxidised sulphate of lead, although it increases the resistance, rather impedes than promotes local action.

On the other hand, however, it is necessary that the reduction of the minium on the opposing plate should be complete, for a mixture of lead peroxide and metallic lead would be peculiarly conducive to the production of lead sulphate, and thus increase the resistance; while if any peroxide should remain, it would diminish the electromotive force of the cell.

It would appear probable, therefore, that the most economical arrangement would be obtained by making the red lead to be hydrogenated much smaller in amount than that to be oxidated. On trying the experiment with only half the quantity, we obtained a most satisfactory result as far as the charging was concerned. How far such an arrangement may be really desirable we hope to consider more fully when we treat of the chemistry of the discharge.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

Report of the directors for the half year ending December 31, 1881, to be presented at the general meeting of shareholders, to be held on Friday, March 31, 1882.

The annexed accounts for the half year ending December 31, 1881, show a balance to the credit of profit and loss of £4,910 13s. 10d. The receipts are in excess of those for any previous half year since the formation of the Company. The Bilbao cable was interrupted on November 28, but was promptly repaired, communication being restored on December 15, and this cable has since then been in perfect working condition, while the Marseilles-Barcelona cable has been throughout the half year (and continues to this day) in excellent order. The cost of repairing the Bilbao cable has, to the extent of £2,880 9s. 9d., been paid out of the revenue of the last half year, £300 having been taken from the reserve fund, leaving a balance of £5,200 at the credit of that fund.

After paying the dividend on the preference shares, amounting to £2,921 10s., there will remain a balance of £1,989 3s. 10d., out of which it is proposed to pay the same rate of dividend on the ordinary shares as for the previous half year, viz., 3s. per share, free of income tax, absorbing £1,939 13s., and leaving a balance of £49 10s. 10d. to be carried forward. The warrants in payment of the Ordinary and Preference dividends will be issued as soon as remittances from Spain for the balance of the telegraph accounts to December 31 last are received. These remittances may be expected in the latter part of April. Mr. Scott and Mr. Bannatyne are the directors retiring by rotation, and, being eligible, offer themselves for re-election. Mr. James Cowan is eligible for auditor for the present year.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices March 22.		Business Done Week Ending March 22. Highest.	Lowest
Anglo-American	51⅛,	52⅛	53⅛	51⅛
Do. Preferred	81½,	82½	83½	81½
Do. Deferred	22½,	23½	24½	23
Brazil Submarine	11¼,	11½	11 5-16	11 3-16
Cuba	8,	8¼	8¼	8¼
Do. Preference	15½,	16½	—	—
Direct Spanish	6½,	6¾	6¾	6¾
Do. Preference	15¾,	16¼	16¼	15 13-16
Direct United States Cable	10¾,	11½	11½	11
Eastern Telegraph	10,	10½	10½	10
Do. 6 per Cent. Preference	12¼,	12½	12½	12 11-16
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11¼,	11½	11 5-16	11¼
German Union	9½,	9¾	—	—
Globe Telegraph and Trust Company.	6½,	6¾	6¾	6 3-16
Do. Preference	12½,	12¾	12¾	12½
Great Northern	12,	12½	12 7-16	12¼
Indo-European	27½,	28½	28	27½
Mediterranean Extension	1¾,	2¼	2¼	2¼
Do. Preference	8½,	9½	—	—
Reuter's	12½,	13½	—	—
Submarine	260,	270	—	—
West India and Panama	1½,	1¾	1 11-16	1¾
Do. 1st Preference	7½,	8	7¾	7¾
Western Brazilian	8½,	8¾	8¾	8 9-16
West. Union 7 per Cent. 1st Mortgage	123,	126	125¾	125¾
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1¾	1 7-16	1 7-16
Oriental	⅝,	¾	¾	⅝
United Telephone	13½,	13¾	13 7-16	13½

ELECTRIC LIGHT.

Eastern Electric Light and Power	5-16,	7-16	—	—
Electric Light and Power	¾,	1	¾	¾
Anglo-American Brush	9½,	9¾	9¾	9

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RECENT INVENTIONS.

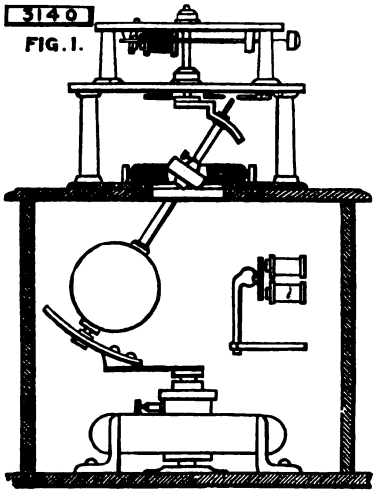
ABSTRACTS OF SPECIFICATIONS.

3015. IMPROVEMENTS IN ELECTRIC LIGHTING APPARATUS, &c., *W. R. Lake, London.*—*8th July*, 1881.—(*A communication from J. J. C. W. Greb, Frankfork, Germany.*)—(*Not proceeded with.*) 4*d.*

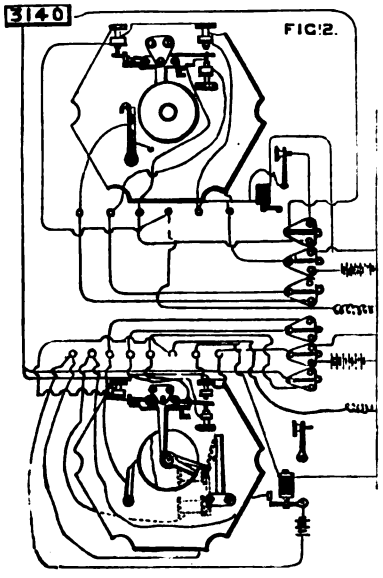
This ivention relates to mechanism for regulating electric lamps, so that a series of such lamps may be included in a circuit in such a manner that one lamp will not interfere with another. Part of the mechanism is also applicable to other purposes.

3140. IMPROVEMENTS IN FAC-SIMILE TELEGRAPHS, *E. G. Brewer, London.*—*19th July*, 1881.—(*A communication from T. A. Edison, Menlo Park, N.J., and P. Keung, New York.*) 8*d.*

The inventors use a pencil or other instrument to mark the paper, and the message is then mounted on an insulating cylinder (of wood) for transmission. The message is received at the receiving office on chemically-prepared paper secured on a metal cylinder. The two cylinders are each mounted on the revolving spindles of the



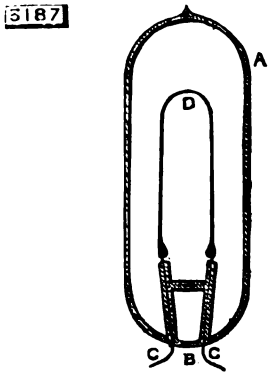
two machines at each end of the line, preferably in a vertical position, and turning through metal



base plates resting on insulating supports. The spindles are revolved by electro-motors. The axle of the motor armature has a crank arm on its upper end, to which is secured a slotted curved plate, in which slides an inclined rod carrying a centrifugal ball and a box at its lower end. The rod passes up into the collar of a universal rocking joint located centrally below the cylinder spindle. From this joint the rod projects upwards to a small box held by a curved slotted crank arm on lower end of cylinder spindle. Click springs are struck by a pin on the rod when the motor runs too fast or too slow. Both transmitter and receiver are synchronous. Fig. 1 gives a vertical section through the motor case, showing motor in elevation; Fig. 2 is a diagram of the circuits.

3187. IMPROVEMENTS IN ELECTRIC LAMPS, *W. R. Lake, London.*—(*A communication from J. V. Nichols, Brooklyn, U.S.*)—*21st July*, 1881. 6*d.*

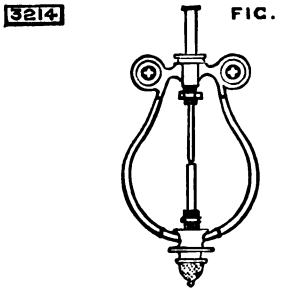
Instead of the ordinary globe with neck to carry the carbon filament, the inventor imbeds his wires in a disc of cement, composed of potash, silica, oxide of iron, and copper, which disc is



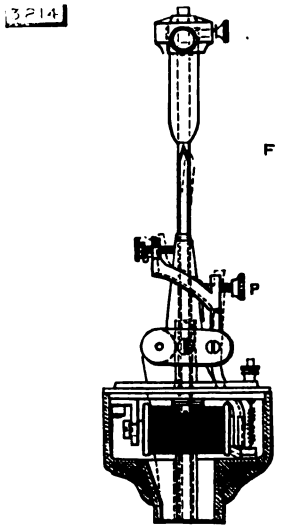
sealed to the globe by means of the blow pipe. The figure shows one form adopted. C C are the conducting wires, coated some way up with the cement; B is a plug of cement, D is the carbon filament, and A the globe.

3214. IMPROVEMENTS IN ELECTRIC LAMPS, *A. M. Clark, London.*—*22nd July*, 1881.—(*A munication from L. J. Bouteilloux and N. Laing, Paris.*) 8*d.*

In the inventor's lamps the feed of the carbons is regulated by gravity. The upper carbon is



solid, and rests by its own gravity on the end of a central non-conducting core contained within

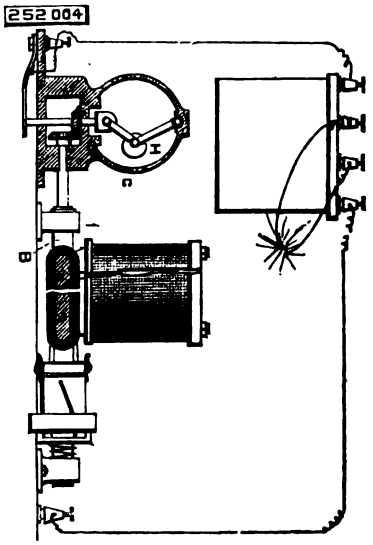


the lower carbon. Fig. 1 shows this form of the lamp. Fig. 2 shows a method of regulating the arc by means of an electro-magnet and shunt circuit. When the arc has to be established or re-established, the lower carbon is caused to deviate from its vertical position when a strong current traverses the magnet until it is no longer opposite the non-conducting core of the upper carbon, but comes opposite the carbon envelope, the arc being instantaneously established, the current in the magnet then diminishes and the lower carbon resumes its vertical position. The lower carbon is kept from pressing too heavily against the non-conducting core by the stop P and apparatus connected. The lower carbon is pushed upwards by a counter-weight attached to the cord shown on the left-hand side of the figure.

252,004. AUTOMATIC CIRCUIT BREAKER FOR SECONDARY BATTERIES, *James A. Malony and Frans Burger, Washington, D.C., Assignors to the American Electrophone Company, same place.*—*Filed September 19th*, 1881.

Brief.—Brakes charging circuit when dynamo-electric machine stops, to prevent discharge through the machine.

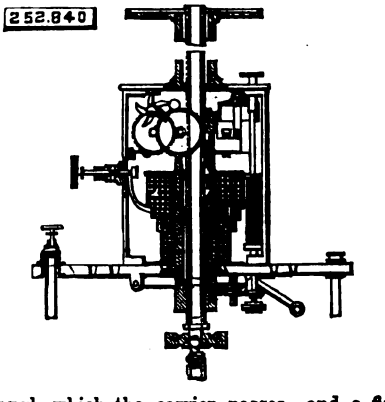
Claim.—(1). An automatic breaker, consisting of the ball H, with its arms, and the shaft, provided with the bevel gear, in combination with the shaft of the armature B of the electric generator, and spring and electric circuit, all constructed and operated substantially as and for the purpose set forth. (2). In combination with an



electrophone or secondary battery and dynamo electric generator, with their circuits, a governor or regulator operated by the direct motion of said generator, in combination with the spring M, substantially as and for the purposes set forth. (3) In combination with a dynamo-electric generator and electrophone or secondary battery, a governor or regulator consisting of the ball H, within a frame G, and its connection with shaft, spring, and contact point, substantially as described, and for the purpose set forth.

252,840. ELECTRIC LAMP, *Hiram S. Maxim, Brooklyn, assignor, by mesne assignments, to the United States Electric Lighting Company, New York N.Y.*—*Filed November 27th*, 1879.

Brief.—The carbon carrier is controlled by a train of gears mounted upon a hollow core,



through which the carrier passes, and a fixed detent is employed in connection with the train. The lamp is suspended by means of a tubular support containing the carbon carrier.

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SLIP

TUNIS.—A telegram from Tunis, dated March 27, says that telegraphic communication with Southern Tunis is completely interrupted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY. — The traffic receipts of this Company for the week ended 24th March amounted to £3,621.

ELECTRIC LIGHT IN BERLIN.—The lighting of the principal streets and squares of this city with electric light is to commence on the 15th of April.

ELECTRIC LIGHT FOR TRAINS.—It is stated that the electric light is being used as a means of illumination for a train running between Calais and Brussels.

ELECTRIC HEADLIGHTS FOR LOCOMOTIVES.—The Paris, Lyons, and Mediterranean Railway Company are about to experiment with an electric headlight for their locomotives.

ROYAL INSTITUTION.—A paper was to be read before this Institution last (Friday) night, by Mr. William Spottiswoode, Pres. R.S., on "The Electric Discharge in a Magnetic Field."

ELECTRIC LIGHT AND ST. LUKE'S VESTRY.—This vestry have appointed a committee to inquire into the practicability of lighting the streets of their district by means of the electric light.

A NEW ELECTRIC TIME LOCK.—At the Royal Institution on the 24th March, Mr. Chubb, of Messrs. Chubb and Son, exhibited in action, and explained, a new electric time lock that has been invented.

PARIS ELECTRICAL EXHIBITION. — Our contemporary *L'Electricité* calls our attention to an error in a recent note, in which the net profits of the recent exhibition in Paris are stated to be 325 francs. This should, of course, be 325,000 francs.

LONDON PLATINO BRAZILIAN TELEGRAPH COMPANY.—The revenue of this company for the month of December is estimated at £2,011 (Western Brazilian portion £1,303, Land Lines £708), as against £2,330 for the corresponding period of 1880.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 24 were £2,418, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

THE TELEPHONE IN SYDNEY.—The latest news from New South Wales says that the necessity of putting the various fire brigade stations in telephonic communication with each other was being urged upon the Postmaster-General by the Volunteer Fire Brigades.

SS. "DACIA."—The India Rubber, Gutta Percha, and Telegraph Works Company received a telegram from Mr. W. Falconer King on Wednesday from Lima, stating that the ss. "Dacia," after taking cargo at Concepcion, in Chili, started on her homeward voyage on the 23rd ult.

THE QUEEN AT MENTONE.—We recently noticed that the French Government had erected a special wire, putting the Queen's villa in direct communication with London. We may also state that, by order of the French authorities, messages sent to the Queen take priority of all others.

ELECTRIC LIGHT IN CHESTERFIELD.—With reference to our note of last week under this heading, we may state that the Hammond Electric Light and Power Company are at present lighting about four miles of streets with 22 arc and 50 incandescent lamps, Brush and Lane-Fox respectively.

ELECTRIC LIGHT IN DUBLIN.—The question of lighting several streets in this town by the electric light is still under consideration by the corporation. It is stated that the offer of one company to light Castle and Mill-streets has been accepted, subject to certain conditions as to the laying of the conducting wires, &c.

NEW CABLE BETWEEN TRIESTE AND CORFU.—The telegraph cable between Trieste and Corfu was handed over for traffic at noon on Friday last, when messages were exchanged direct between Trieste and Zante, Syra, and Alexandria. The cable is a new and important link in our means of communication with Egypt and the East.

ELECTRIC LIGHT IN MADRID.—A committee appointed to consider the question of lighting the principal streets of this city by means of the electric light have recently accepted the offer of the Electric Light Company of Barcelona, of which Senor Roig y Torres is the manager. Preliminary trials are to be made in some of the chief streets and in two theatres.

TELEGRAPH WIRE WANTED.—The Lancashire and Yorkshire Railway Company are inviting tenders for the supply of telegraph wire. Forms of tender, &c., can be had at the Store Department, Miles Platting, near Manchester. Tenders must be addressed to the directors and sent to the secretary, Mr. J. H. Stafford, Hunts Bank, Manchester, by 10 a.m. on the 10th April.

ELECTRIC LIGHT AT STRASBOURG.—*La Lumière Electrique* says that the Grand Taverne Alsacienne at Strasbourg is now lighted by Edison lamps. The engine which is used to pump water to the various storeys, and perform other work, is brought into requisition for driving a Gramme machine, which gives sufficient current for 45 small lamps. The steam engine is of 4 horse-power.

ANOTHER ELECTRICAL CONGRESS.—A congress, the outcome of that held in Paris last year in connection with the Exhibition, is to be held in that city this month, to deal with the questions of international legislation for the protection of cables, the exact length of the mercury column representing the ohm unit, a new photometrical standard, and the best means of studying the phenomena of atmospheric electricity.

ATLANTIC CABLES.—Various rumours have been abroad within the last few days as to what effect Jay Gould's new Atlantic cables would have on the present tariffs. We believe that a definite arrangement has at length been come to by all the companies owning Atlantic cables to revert to the old rate of two shillings a word, instead of one shilling as at present. This decision will probably take effect shortly.

THE MANUFACTURE OF SWAN LAMPS.—The correspondent of a contemporary representing the gas interest says:—"I paid a visit the other day to the works of Messrs. Mawson and Swan, in Newcastle, where the Swan lamp is manufactured. The manager informed me that more than a hundred women are employed in the works, and that the sale of incandescent lamps averages between 4,000 and 5,000 per week."

THE TELEPHONE IN FRANCE.—It is rumoured that the authorities of the French Post Office intend to buy up the patent rights of the telephone in France. It is proposed to open stations in connection with the present telegraph offices, at which the public, without becoming subscribers, may communicate with subscribers at a charge of half-a-franc for every five minutes' conversation, as has been done in Germany and Switzerland.

EASTERN TELEGRAPH COMPANY.—This company announce

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the payment on April 14 next of 3s. per share interest on their Six per Cent. Preference shares, for the quarter ending March 31, 1882; and also of an interim dividend of 2s. 6d. per share on the ordinary shares, in respect of profits for the quarter ended December 31, 1881. The half-yearly interest on the Six per Cent. Debentures will be paid on the above date at the banking house of Messrs. Glyn, Mills, Currie, and Co.

Electric Light for the Clock Tower at Westminster.—In reply to a question from Mr. Spencer, Mr. Shaw Lefevre, First Commissioner of Works, stated that nothing was likely to be done in the way of substituting an electric light for the present gas light on the clock tower, until the question of lighting the House of Commons had been decided. Mr. Lefevre further stated that it was a moot point whether gas or electric light could be best seen in a fog, but he thought that the general belief was in favour of the latter.

Electric Light at Burton-on-Trent.—At a conversazione held in Burton-on-Trent a day or two ago the rooms were lighted by means of Maxim incandescent lamps, supplied by Messrs. Davis and Son, of All Saints' Works, Derby. The necessary current was generated by a dynamo-machine driven by an ordinary steam engine used by Messrs. Buxton and Thornley in their engineering shop adjoining the hall in which the conversazione was held. Some lamps have also been fixed in the billiard room of the Liberal Club in this town, and are said to have given great satisfaction.

The Faure Battery.—A correspondent writes to the *Engineer* as follows:—"At the meeting of the Society of Engineers on Monday night (the 20th March) it was stated by one electrician of repute that it is possible to charge a Faure battery and at the same time to use the charging current for generating the electric light. It seems to me that this proposition runs counter to the conservation of energy theorem, which has already been disputed by some physicists on the Continent, who assert that, if it be true, the received dynamical theory of the energy of a perfect gas must be wrong."

Central and South American Telegraph Company.—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from Mr. E. W. Parsoné, engineer in charge of the ss. "Retriever," reporting that the soundings he has taken with that vessel over the route selected for the Central and South American cables give excellent results. There is no difficulty in selecting a good bottom in 300 fathoms, and there are no rocks to be found to the north of Santa Elena, Ecuador. The "Retriever" is now completing the detailed soundings at the various landing places.

Electric Railway for Berlin.—The question of an electric railway for Berlin is being considered. The railway would run from the west to the east of the city, and would establish direct communication with the metropolitan railway. It is to be constructed overhead, and supported on high columns. Stations will be erected at Lutzow Square, Magdebourg Square, Potsdam Station, Dœnhof Square, &c. The trains are to lower themselves on arriving at each station to the level of the street for passengers to get out and enter, and will then again be elevated to the level of the line overhead, all this being accomplished by power supplied by means of electricity.

New Company.—The formation of the Electric Lighting Contract and Maintenance Company is announced, the capital of which is £2,003,000, in 200,000 "A" shares of £10 each, with power to increase, and 300 "B" shares of £10 each, fully paid up. It is intended to call up only £5 per share at first. The company has been formed to act as an independent medium between the public and the various manufacturing and patentee companies to supply the electric light by contract, &c., to public bodies and for domestic use, and also to supply electricity as a motive power. The temporary offices of the company are at 5, Lombard-street, E.C., Mr. F. R. Grigg being the secretary.

Protection Against Fire in Birmingham.—At a meeting of the Watch Committee held this week a report was received from the fire brigade sub-committee, which stated that the fire-engine station was placed in communication with the police station by means of a line of telegraph and Siemens' instruments. A telephonic line had been established to the superintendent's house by Messrs. Radcliffe; a telephonic line was established with the Prince of Wales Theatre, at the cost of the lessee of the theatre; and a telephonic line was established with the Telephone Exchange, at the cost of the National Telphone Company. Electric bells had also been fitted for calling up the men at the various stations.

The Conductivity of Iron and Steel.—According to a Swedish paper, the *Jern Kontorets Annaler*, the conductivity of drawn wire not annealed is bad, being weakened by drawing. The following results are given of tests made with the following makes of iron and steel:—Wrought iron from Lancashire forges, containing ·04 to ·08 of carbon, had a conductivity of 15·75 to 15·17. The remaining figures were as follow:—Open hearth steel, carbon ·04 to ·08, conductivity 14·97 to 14·17; Martin Bessemer steel, carbon ·08 to ·15, conductivity 14·17 to 13·76; ditto, carbon ·15 to ·25, conductivity 13·76 to 13·02; Bessemer steel, carbon ·25 to ·40, conductivity 13·02 to 12·50; ditto, carbon ·60, conductivity 11·85; ditto, carbon ·80, conductivity 10·66.

Exhibition of Life Saving Apparatus.—An exhibition of means and appliances for the protection and preservation of human life is to be held at the Alexandra Palace, from the 26th June to the 22nd of July next. The exhibits will include the following, amongst others:—Class 1: Apparatus and models of railway signalling and safety appliances; class 2, mining safety appliances; class 3, contrivances for the prevention of street accidents; class 4, apparatus employed for the prevention and extinction of fires and means and appliances for rescuing life; class 5, protective provisions for dwellings and other houses; class 6, improvements in firearms and explosives; devices to facilitate their safety, and prevent their accidental discharge or ignition; class 7, engineering safety appliances. Amongst these we shall expect to find many in which electricity is made use of in one way or another.

The Paris Exhibition.—We have received a copy of the report of Signor D. V. Piccoli, the Italian delegate to the Paris Electrical Exhibition, presented to the Ministry of Agriculture, Industry, and Commerce. It comprises a general introduction, in which the exhibits of Italy are spoken of as being few, but of great importance, such as the Pacinotti machine, the precursor of all the varied forms of dynamo machines now in existence. The various applications to which electricity can be put in the several industries and arts are then dealt with, including mining operations and forestry, agricultural work, manufacturing industries, and commerce generally. In conclusion Signor Piccoli states his opinion that a great future lies before electricity, and expresses the hope that it may not be long before his own Government will be in a position to institute a similar exhibition to that which has proved so successful at Paris.

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Post Office Telegraphs.—In addition to the particulars as to the revenue and expenditure for 1880-81 under the head of Post Office Telegraphs which we gave in a recent note, the following items abstracted from the recent Parliamentary return may be of interest. The total amount received from the date of the transfer of the telegraphs to the State, February, 1870, to March 31, 1881, was £13,226,047 13s. 0¾d., and the total expended £11,229,051 8s. 10d., leaving a balance of £1,996,996 4s. 2d. In 1871 the receipts were £735,390 0s. 1d., and the expenditure £496,694 16s. 3d., leaving a balance of £238,695 3s. 10d., whilst in the year ending March 31, 1881, the receipts were £1,633,886 14s. 9¾d., and the expenditure £1,368,453 19s. 3¼d., leaving a balance of £325,432 15s. 6½d. The receipts in 1881 were the highest that have been recorded since the Goverment took over the telegraphs.

Crystal Palace Electrical Exhibition.—On Saturday evening last a visit was paid to this Exhibition by their Royal Highnesses the Prince and Princess of Wales, and other distinguished personages. The Prince and Princess were conducted over the Exhibition by Mr. M'George and Dr. Read (the chairman and one of the directors of the company respectively), and Major Flood Page, manager, and Mr. Gardiner, secretary to the company. The Edison exhibit was much admired by their Royal Highnesses, the Princess being pleased to accept as a *souvenir* of her visit a bouquet of leaves and flowers made of hammered brasswork, with an Edison incandescent lamp rising from the centre, the work of Messrs. Verity and Sons, of King-street, Covent-garden, W.C. A novelty had been introduced especially for this evening in the shape of a new secondary battery, the invention of Messrs. Sellon and Volckmar, which was shown by the Electrical Power Storage Company. A number of these secondary cells were used to supply the current required for lighting the Lane-Fox lamps, shown by the Brush Electric Light Company in the Alhambra Court. As we hope shortly to give a description of this new battery, we shall not say more here than that it seemed to act very effectually.

The Government and Electric Lighting.—Replying to a recent deputation representing the Dundee Gas Commission, Mr. Chamberlain, President of the Board of Trade, gave some explanation of the general measure which the Government are about to introduce dealing with the electric lighting question. He explained that the intended Bill would enable corporations either to supply the electric light themselves or to sanction its supply by private companies previously licensed by the Board of Trade. In cases where the municipal body refused to take either course, private companies might independently apply to the Board of Trade for a provisional order which, if passed, would go before a Select Committee as private Bills now did. His object was not to discourage the progress of electric lighting, but rather to improve it, and at the same time to secure that private companies should not obtain exclusive powers for an indefinite period or be enabled afterwards to turn round upon municipalities for compensation in respect of large profits. The Bill which he proposed to introduce would avoid these dangers. Provisional orders would only have a duration of seven years, at the end of which time a local corporation could take over the undertaking at the actual value of plant, &c., irrespective of accrued value for trade profits.

Crystal Palace Electrical Exhibition.—The Jury.—The Directors of the Crystal Palace Company state that, acting on the recommendation of the Honorary Council of Advice in connection with the International Electrical Exhibition now being held, they have appointed the following 21 British jurymen—viz., Captain F. W. Abney, R.E., F.R.S.; Professor W. Grylls Adams, F.R.S.; Major R. F. Armstrong, R.E.; Professor W. E. Ayrton, F.R.S.; Shelford Bidwell, Esq.; Sir S. Canning; Professor R. B. Clifton, M.A., F.R.S.; T. R. Crampton, Esq., C.E.; Horace Darwin, Esq.; Professor G. Carey Foster, F.R.S.; Professor E. Frankland, F.R.S.; Captain Douglas Galton, C.B., F.R.S., F.R.G.S., F.G.S., F.L.S., D.C.L.; Lieut.-Colonel W. Haywood; Dr. J. Hopkinson, F.R.S.; Professor D. E. Hughes, F.R.S.; Professor Fleming Jenkin, F.R.S., M.I.C.E.; Professor J. W. Keates; W. H. Preece, Esq., F.R.S.; Professor Sylvanus Thompson, B.A., D.Sc.; C. E. Spagnoletti, Esq., C.E.; and Lieut.-Colonel Webber, R.E., President of the Society of Telegraph Engineers. The first meeting of the British section of the jury was held at the Crystal Palace on Tuesday evening last, at which nearly the whole of the jury were present. Some of the foreigners who have been asked to act on the jury have already accepted, and the names of the foreign jurymen will be announced as soon as the list is completed.

Superintendents of Telegraph Offices. — In the House of Commons, on Friday week, Mr. Macfarlane, in the absence of Mr. Gray, asked the Postmaster-General whether it was a fact that the superintendent of the Belfast Telegraph Office was about to be appointed to the vacant superintendentship of the Dublin Telegraph Office; whether such appointment was not contrary to the regimental system of promotion hitherto observed, by which the vacancies at the respective offices were filled up by the appointment of officers attached to the staff in which the vacancy occurred; whether a similar violation of that system of promotion did not also recently occur by the promotion of a clerk from Newcastle-upon-Tyne to the post of technical officer at Dublin, thereby depriving the Dublin Telegraph Office of three promotions; whether the contemplated promotion of the superintendent at Belfast to Dublin would deprive them of four promotions; whether it was a fact that on several occasions the Dublin telegraphists had received the thanks of the London secretary for the creditable manner in which they had performed their duties; and whether he would state to the House why they were now punished by depriving them of their legitimate promotion? Mr. Fawcett, in reply to the hon. member, said: I have to state that it is the case that the superintendent of Telegraphs at Belfast has been appointed superintendent of telegraphs at Dublin, in the room of an officer transferred from Dublin to Belfast. There is nothing unusual in such an appointment, and the Dublin officers are not prejudiced by the change. The appointment of Technical Officer was recently created at Dublin, and a clerk from Newcastle-on-Tyne was promoted to it. I consider it of great importance in the interests of the service that no strict line of demarcation should be laid down, but that there should be freedom of transfer, not only between office and office in the same part of the kingdom, but between one part of the kingdom and another. In several instances officers have been brought from Scotland and Ireland to fill appointments in England, and in the same way I think it desirable to have an opportunity of sending officers from England to Ireland and Scotland, when, as in the recent case of the clerk detached from Newcastle-on-Tyne, the interests of the service appear to be promoted by it. I am pleased to be able to state that on more than one occasion within the last year or so the Dublin telegraphists have received thanks from head-quarters in London for the creditable manner in which they have performed their duties.

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CRYSTAL PALACE EXHIBITION.

The Hammond Electric Light and Power Company's Exhibits.

The following experimental data and deductions therefrom are given by our contemporary the *Engineer*, and having such evident interest for everyone connected with electric light operations, we reprint below the major portion of the article.

In addition to the information given in our contemporary, a more detailed account of this Company's exhibits may be here interpolated:—

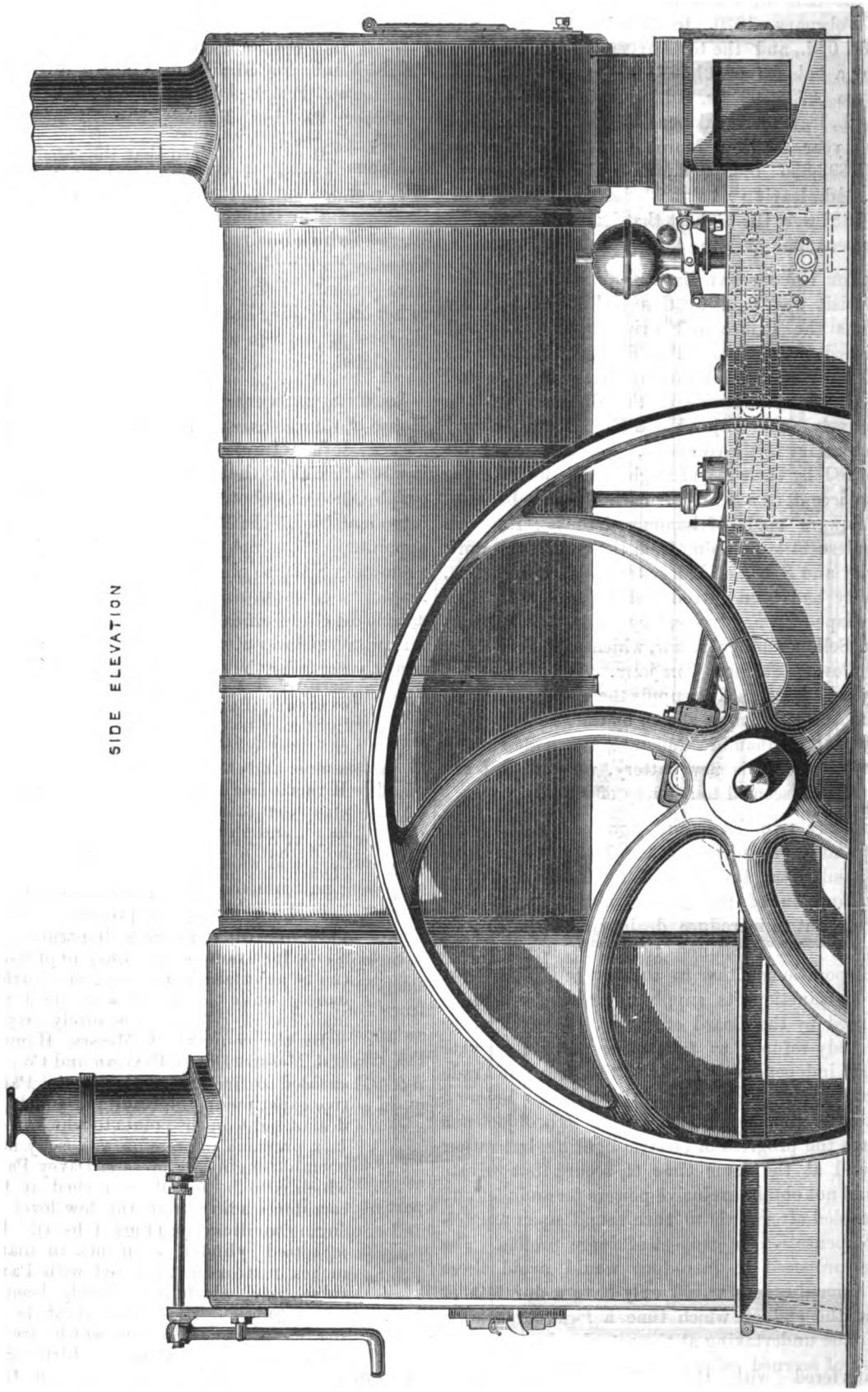

FIG. 1.

The Hammond Company are the concessionaires for the Brush system for the counties of Northumberland, Cumberland, Westmoreland, Durham, Lancashire, Yorkshire, Derbyshire, Sussex, and Hampshire. The exhibits at the

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Crystal Palace are arranged in the passages and corridors leading from the London, Brighton, and South Coast Railway Station to the entrance of the Palace, and the company is, therefore, able to show exactly what the Brush lights can do by themselves, a feature which the Palace authorities are happy in fostering, as at Paris one light interfered with the other. The dynamo machines and engines are placed in the centre of their exhibit, so that the lamps and dynamo machines comprise an easily inspected installation. The piece of ground upon which the exhibit stands is known as the North Lawn, but all traces of the lawn have disappeared, as the exhibitors have erected a galvanised iron building to contain their machinery.

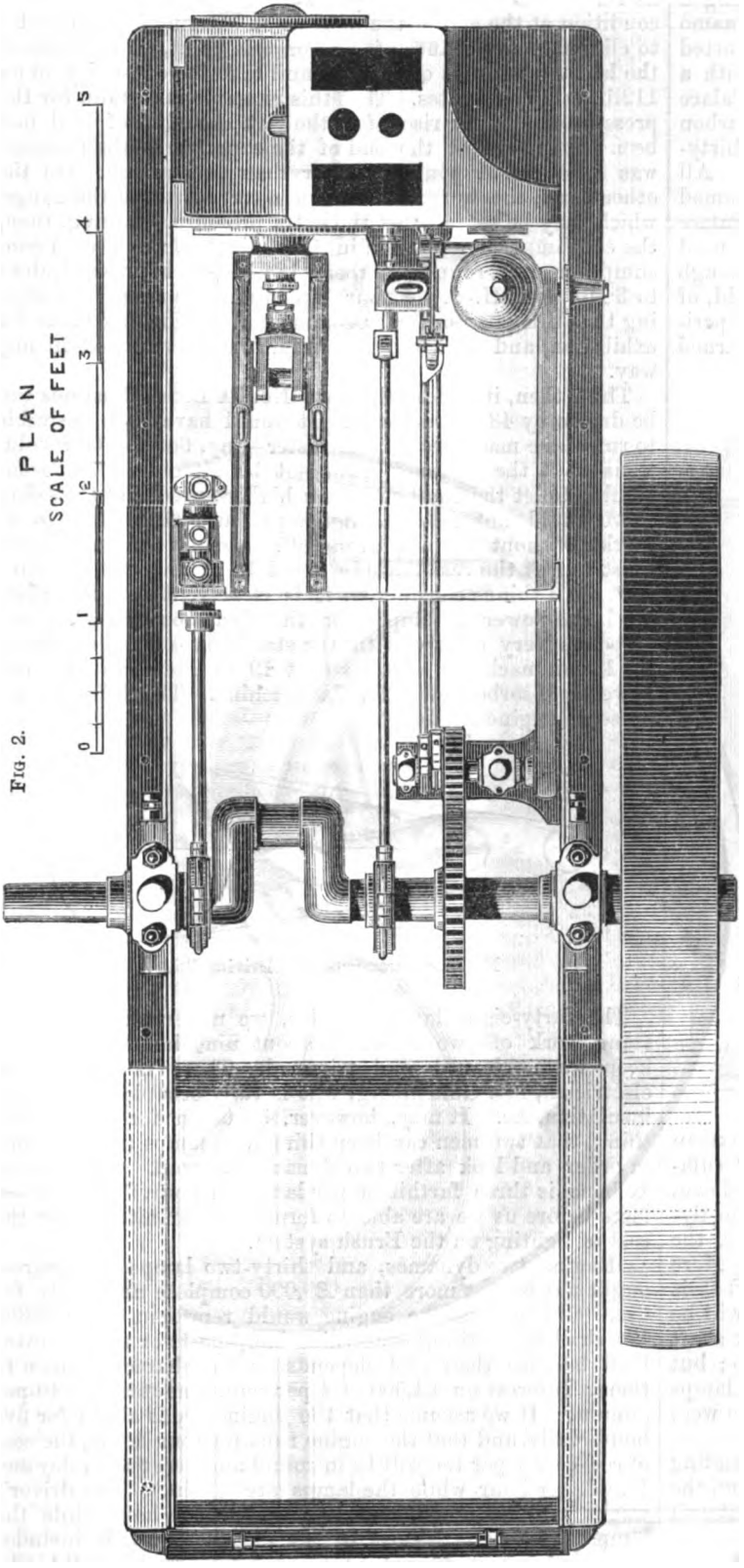

Fig. 2.

Besides the engine experimented with, there is also a 28 h.-p. engine (Fowler's) capable of running 4 dynamo machines, and actually running 2 of what are technically known as 16 lighters; also a Hornsby's 10 h.-p. engine suited for one 16 light machine. These engines are of the semi-fixed type, and have their boilers above the engines, so that they are compact in themselves, and are admirably adapted for lighting railway stations, docks, &c., where no boiler power is available. They can, of course, be easily moved about from place to place.

It will be noticed that the capacity of the dynamo machines is 70 lights, all these of 2,000 candle-power nominal, and in order to show the machines working to their full capacity the whole of the lamps which it is possible to run are placed in the corridors adjoining, the result being that a very brilliant lighting is obtained.

In the corridors and passages 58 lights are hung, with four lights in the building containing the dynamos, the remaining power being used for Lane-Fox lamps in the Technological Museum.

Half the lamps are covered with albastrine opal globes, 15 of them are covered with plain globes, and the remainder with coloured globes. Special forms of street lamps are also exhibited at intervals.

Having described the general details of the Company's exhibit, we give below the abstract from the *Engineer* mentioned above :—

" Whether a good light can or cannot be obtained from electricity is no longer an open question. Instead we have now as a problem for discussion, the cost of electric lighting. It happens that very little definite information exists on this point. It may be urged as an explanation of the fact that the light has not been long enough in existence to permit any accurate information to be obtained concerning its expense. But this is hardly true. The cost of the light may be classed under three heads, namely (1) the first cost of the plant; (2) the cost of fuel, lamps, and attendance; (3) the cost of maintenance. Hitherto statements concerning these things have emanated principally from gas engineers on the one hand, and electricians on the other. The gas folk hold that electricity is dearer than gas, while the electricians maintain that it is cheaper. The utterances of both parties are obviously tinged with a suspicion that they are prejudiced; yet it ought not to be difficult to arrive at the truth. If we take arc lamps for example the power required to work them can be ascertained, also the cost of carbons and attendance; while to find out what the annual outlay for maintenance represents is surely easy enough.

By the courtesy of Messrs. Hammond and Co. and Messrs. Davey Paxman and Co., we have been enabled to carry out at the Crystal Palace an instructive experiment, the results of which throw a good deal of light on the points to which we have referred. In a previous impression we briefly noticed a semi-portable engine by Messrs. Davey Paxman and Co., which is to be found in a shed at the side of the corridor leading from the low level station. This engine we illustrate (Figs. 1 to 3). It has an unjacketted cylinder, 12 inches in diameter and 14 inches in stroke; it is fitted with Paxman's patent valve gear, which has already been described in our columns. The valve chest is fitted with a species of inner lid, in which are several small ports—on which slides a little gridiron valve. The inner lid is close to the back of the main slide valve, and the small gridiron valve serves to cut off the steam. This valve is worked by an excentric mounted on a countershaft, and making two revolutions for one of the engine, motion being imparted to it by a pair of engine-cut toothed wheels. On the countershaft a sheave is

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keyed beside the excentric. This sheave is fitted with a hoop, and a rod from it extends to one end of a link, while the excentric rod is secured to the other end of the link; a lever from a high-speed loaded governor is coupled to the link, and by this means the travel of the gridiron cut-off valve can be varied in a way which will be understood without further explanation by engineers. The cut-off takes place very quickly, the gridiron valve having a stroke of but half an inch, and the engine drives the dynamo with remarkable regularity, the hand of the tachometer fitted to the machine remaining at rest—a wonderful result with a single cylinder engine. Distributed through the Palace Messrs. Hammond and Co. have forty-eight double-carbon Brush lamps, and they placed at our disposal thirty-two of these lamps for the purpose of experiment. All the lamps were fitted with short carbons. It was not deemed advisable to try an experiment at night, when the Palace was crowded with visitors, so the lamps could only be used for one hour, as otherwise there would not be carbons enough left to maintain the light from 6 p.m. to 9:30. It would, of course, have been desirable to make a more prolonged experiment, but it will be seen that a great deal can be learned even from an hour's run concerning the electric light.

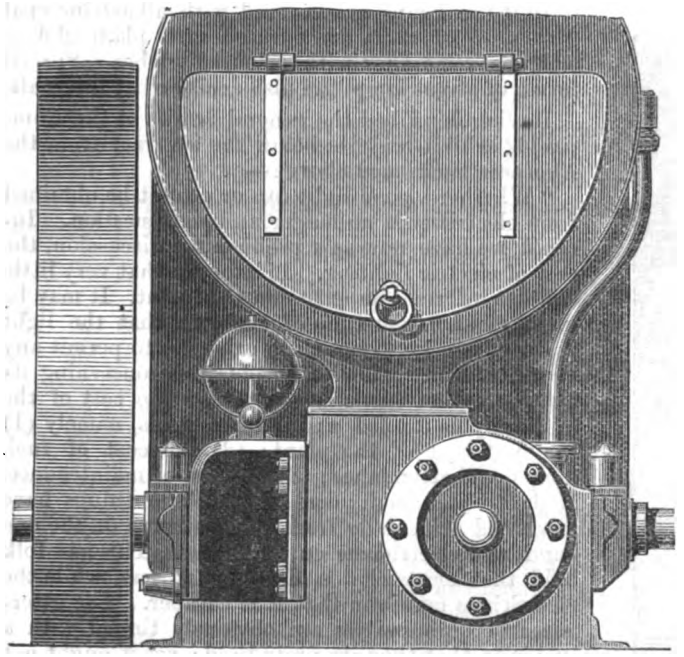

Fig. 3.—End Elevation.

We stated in a previous impression that the Davey Paxman engine was driving one 7A Brush dynamo. This is not sufficient load for the engine, so a spare dynamo was put down, and driven by a riding belt. The engine has only one fly-wheel, and one belt had to run on top of the other, the arrangement being as shown in the diagram (Fig. 4). Here A is the fly-wheel, B is the dynamo regularly used, and C is the dynamo added for the purpose of experiment. It will be seen that this was unfair to the engine, as one crank shaft bearing had to stand the strain of two double 8in. belts; but there was no approach to heating. The sixteen lamps ordinarily driven by Messrs. Hornsby and Son's engine were coupled on to the extra dynamo.

At 2:20 p.m. the engine was started, the gauge standing at 70lb., and but little fire on the grate. At 2:26 p.m. the counter was put in gear, and firing commenced with Welsh coal; we could not ascertain what coal, but we believe Powell's Duffryn, and of excellent quality. Steam was gradually raised to 75lb., and at that it was kept by a very skilful fireman with great steadiness. The dynamo made 650 revolutions per minute; the engine 122·1. Exactly 1 cwt. of coal was put into the fire box between 2:26 and 3:15 p.m. The engine continued to run from 3:15 to 3:26, when the pressure had fallen to about 72lb. The indicator was then thrown out of gear, and the experiment concluded. About a dozen diagrams were taken during the run, but it was soon found that they were all practically alike, as was to be expected, because the load and boiler pressure were steady. The average of several gives 43 horse-power. Thus it would appear that 43 horse-power could be had for 1 cwt. of coal per hour, which is equivalent to 2·6lb. per horse-power per hour. So far as could be judged by the eye, the fire was in the same condition at the end of the hour as on starting; but in order to eliminate any chance of error on this point, we shall reject the last ten minutes of the run, and take the consumption as 112lb. in fifty minutes. That this is ample is certain, for the pressure tended to rise after the last shovelful of coal had been put on, and at the end of the experiment the pressure was a couple of pounds higher than at starting. On the other hand, the water had fallen a very little in the gauge, which may be set against the extra pressure. Taking, then, the consumption at 112lb. in fifty minutes, we have a consumption of, in round numbers, 134lb. per hour, equivalent to 3·1lb. per I.H.-P. per hour—an admirable result, considering that this is an ordinary commercial engine, not made for exhibition, and that the feedwater was not heated in any way.

Thus, then, it is clear that two No. 7A Brush dynamos can be driven by 43 horse-power. It would have been desirable to run these machines a little faster—say, 680 to 700 revolutions—but the governor could not be altered without some trouble to let the engine run at a higher speed, and the safety valve would not allow a higher pressure than 75lb. to be carried without risk of blowing off. Against the lower speed must be put the resistance incurred by driving with a riding belt. All things considered, it is clear that with this plant 43 horse-power is ample for the dynamos, and this corresponds very closely with the statement of the makers of the Brush machines, who say that 19 to 20 indicated horse-power is absorbed by a No. 7A machine. The difference represents engine friction.

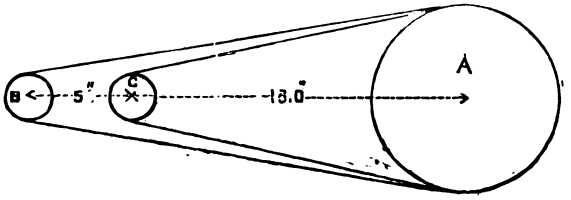

Fig. 4.—Arrangement of Driving Belts.

The forty-eight lamps require, we understand, the constant work of two men for about nine hours per day to keep them cleaned and trimmed. There is besides an electrician, Mr. Goldenberg, who is fully occupied in testing insulation, &c. It may, however, be taken for granted, we think, that two men can keep thirty-two lamps trimmed and in order and look after two dynamos as well. The cost of carbons is three farthings per lamp per hour. With these facts before us we are able to form some definite idea of the cost of lighting on the Brush system.

Engine, two dynamos, and thirty-two lamps, with wires, ought not to cost more than £1,000 complete and ready for use. Of this sum the engine would represent about £300. We shall say nothing concerning lamp-posts or their equivalent, because their cost depends on the character given to them. Interest on £4,000 at 4 per cent. amounts to £40 per annum. If we assume that the engine fire is alight for five hours daily, and that the engine runs for four hours, the cost of coal at £1 per ton will be in round numbers 6s. per day and 1s. 6d. per hour while the lamps are alight. The driver's wages will be, at 5s. per day, 1s. 3d. per hour while the lamps are alight. Cost of maintenance, which includes depreciation and outlay for repairs and renewals of all kinds, at 20 per cent. per annum, is £200 a year, and 2s. 8·87d. an hour. The cost of carbons at $\frac{3}{4}$d. per lamp per hour will be 8d. per day, or £146 per year. Wages of two lampmen at 7s. per day, £255 10s. Something may have to be added for rates and taxes, water, and rent of premises, but in the country £100 per annum ought to be sufficient. The whole

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bill then stands at £942 5s. per annum for working thirty-two Brush arc lights every day in the year for four hours. Adding £58 for oil and contingencies, we have a total outlay of £1,000 a year. We have collected the several items for convenient reference into the following table of total expenses:—

—	Per year.	Per day.	Per hour the lamps are alight.
	£ s. d.	£ s. d.	s. d.
Interest at 4 per cent. on £1,000	40 0 0	0 2 2·6	0 6·65
Coal at £1 per ton	109 10 0	0 6 0	1 6·00
Driver's wages	91 5 0	0 5 0	1 3·00
Cost of maintenance at 20 per cent.	200 0 0	0 10 11·5	2 8·87
Do. of carbons	146 0 0	0 8 0	2 0·0
Wages of two men	255 10 0	0 14 0	3 6·0
Rent, taxes, and rates	100 0 0	0 5 5·75	1 4·43
Total cost of working 32 arc lights	942 5 0	2 11 7·85	12 10·195

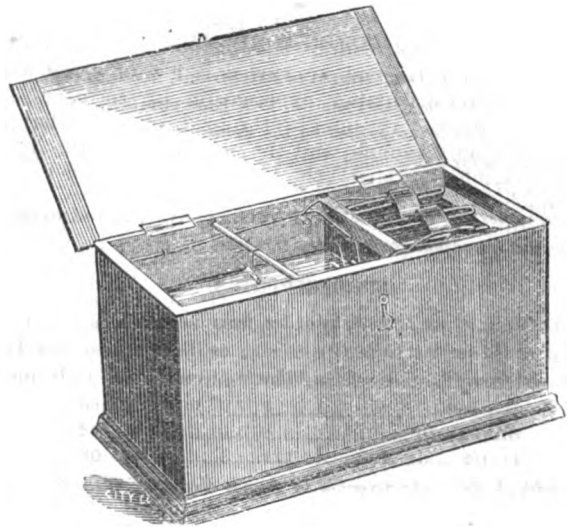
It will be seen that the cost of carbons for the lamps considerably exceeds that of the coal for the engine. We have charged the coal at £1 per ton, but this is a very high price for engine coal. If we take 10s. as a fair price, it will be seen that coal becomes quite an insignificant item. We believe that all our figures will be found trustworthy. The item for lamp men would, perhaps, be best divided into two sums of 10s. and 4s. per day, the man who received the highest wages being supposed to know enough about electricity to test for insulation, &c., while the other would be little more than a labourer, or a stout lad learning his business.

With the data before us we can draw a comparison between the cost of street lighting for a small town with gas and electricity. The plant required to make gas for, let us say, 500 street lamps, which will suffice for, say, five miles of streets, cannot be less than £2,000. But instead of giving all the items of the cost of making gas, as we have done in the case of the electric light, we shall take gas at 5s. a thousand cubic feet—and no small town can expect to obtain gas for less, because it is only when manufactured on a large scale that the bye products become of much value. Each lamp will use five cubic feet per hour, or, in all, 2,500 cubic feet. The cost of lighting will, therefore, be 12s. 6d. per hour, or within a trifle of the sum named in the last column of the preceding table. But to this must be added something for cleaning, lighting and repairing the lamps, so that the whole cost will be considerably in excess of 12s. 11d. per hour. But for 12s. 11d. per hour the electric arc gives us a light of 64,000 candles, while the gas gives a light of but 10,000 candles, if the best possible burners are used. Thus estimated, in terms of candle-power, gas is actually 6·4 times dearer than the electric arc light. It may be argued with some force that 500 street lamps will be on the whole better adapted to the wants of a small town than thirty-two arc lights. But it does not appear to be necessary to use lamps of 2,000 candle-power. Messrs. Siemens have at the Crystal Palace a street lamp which appears to be just what is wanted. We have not measured its intensity, but it is probably less than 1,000 candle-power. Sixty-four such lamps would, if judiciously distributed, light up a small town very well indeed.

Meanwhile we venture to hope that the figures we have placed before our readers may be found useful. That they are trustworthy concerning all that came under our immediate observation there can be no doubt; and we feel certain that engineers generally will admit that our estimates are consistent with the best practice and with their own experience."

Electro-Plating Apparatus.

By an inadvertency the block illustrating this apparatus, which was described in our last issue, was not given with the description. The illustration taken with our description



Chaster's Electro-Plating Apparatus.

is sufficiently explanatory of the apparatus. The designer's name is Mr. J. E. Chaster, of Deansgate, Manchester.

THE ECONOMY OF THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A few months ago I received orders from two firms in Cork to supply electric light apparatus. The first was for Messrs. Furlong and Son's flour mill, and the second was for a similar establishment belonging to Messrs. Hall and Co.

The plant consisted of R. E. Crompton and Co.'s Bürgin machine and Swan's incandescent lamps. Both of these installations have been working most satisfactorily, and only yesterday I received a report, in which it was stated that Messrs. Furlong much preferred the light to that of gas, that the dynamo machine gives no trouble, and that the durability of the lamps has far exceeded anticipation, most of them having been in operation over 1,000 hours, and are apparently as good now as when put up. The average time each week the lights are in operation is upwards of 90 hours—viz., from afternoon of one day until the following morning, being a continual run without stoppage.

The cost of working Messrs. Furlong's lights, including renewals, has been returned to me as under 10s. per week, against £2 5s. per week paid previously for gas for similar hours of lighting. The cost of the power was not, however, included; but allowing 3lb. of coal per i. h.-p. per hour, which are amply sufficient, the drive being obtained from the main compound engine, the cost of fuel would be under 7s. per week. After due allowance for interest on capital and depreciation, the saving over the gas represents more than 50 per cent.

When the electric light in these mills was first started I anticipated the flour would be superior, being free from any contamination from the vitiated atmosphere produced where gas is burned. This anticipation has been realised, the flour now produced being superior to what it formerly was.

I think these facts are an answer to the oft-repeated assertion that dynamo machines were difficult to keep in order where long, continual runs were necessary; that incandescent lamps were not durable in actual operation; and that the cost of the electric light exceeded that of gas.

The result of these instalments speaks well for the Bürgin machine and Swan lamps, as the latter are receiving a current of 1·3 to 1·4 amperes, and I think the energy displayed by Messrs. Furlong and Hall in adopting the electric light as a permanent means of illumination, and being thus the pioneers in this country in the use of incandescent lamps, deserves the good wishes of all electricians.—Yours, &c.,

J. H. GREENHILL.

35, Mill-street, Belfast, 28th March, 1882.

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THE TELEPHONE.

In another column we give a report of the excellent lecture delivered by Professor Dolbear, of Tufts College, Massachusetts, U.S., before the Society of Telegraph Engineers, at their last meeting on Thursday, March 23rd. It was a field night at 21, Great George-street, for we had all heard of Professor Dolbear again and again, and there was some commendable curiosity to see the man as well as to hear his apparatus working. Recollections of a night some few years ago, when Professor Graham Bell explained his speaking telephone to an English audience for the first time, came back to us, and for the second time we were about to meet a transatlantic brother electrician and hear him expound the genesis of his invention. Like Professor Bell, Mr. Dolbear is a clear, collected speaker, keeping a firm hold of his line of argument, and never distracting the attention of his audience by rambling incidents or confusing side issues. His history of the antecedents of the telephone was remarkably lucid, and the facts which he gave about the researches of Mr. Farrar, the New Hampshire electrician, who followed Page, and was the first to try to telephone the human voice would be new to many of his hearers. Farrar, it appears, was deterred from prosecuting his experiments in this direction by the expressed opinion of a leading American scientist in his day, who was mistaken enough to advise him that it was impossible to telephone the human voice. The incident only shows how great authorities may err; and that it is generally better to ask of Nature herself than any scientist whatever. Many valuable results have been lost to the world through the "authoritative" utterances of eminent men of science, who are just as fallible as other men. The investigator's best plan is to work out his own ideas. If he succeeds well and good; if he fails he will at least have learned something with a certainty which attaches to no human opinion.

The account given by Professor Dolbear of how he arrived at the telephone receiver, which he exhibited to the meeting, was very interesting, and illustrates how two discoverers may arrive at a somewhat similar invention by totally different lines of thought. This was the case with Professor Hughes in his discovery of the microphone. No doubt the Dolbear telephone is similar in principle to the singing and speaking condenser of Varley and its successors, but the instrument itself in form and detail is a different appliance altogether. It must be regarded by all practical men as a new telephone, and one which does not conflict at all with the telephones already in use. There can be no question of likeness between the electro-magnetic receiver of Bell or the electro-chemical receiver of Edison and the electrostatic instrument of Dolbear.

The union of the Edison and Bell interests in this country has produced a strong corporation, which has hitherto been without any important rival. What opposition they have met with has been speedily suppressed, and there is, as every electrician knows, a law case pending now in which the United Telephone Company seeks to stop another maker of telephones from doing telephonic business. We do not intend to discuss the merits of this case; but, as we see one effort after another to give the public cheaper telephonic communication suppressed, we cannot help feeling some gratification that there are telephones which do not and cannot come within the scope of the Bell and Edison patents. New inventions of this kind are a wholesome check upon the grasping spirit of a too selfish monopoly, and are to be welcomed in the public interest.

It is true that telephone work favours monopoly, for in any one community there should be free communication through all the parts; that is to say, it is better to have each town or district in the hands of one telephone company controlling all the exchanges. But there are towns and towns, districts and districts, so that it is possible for two or more different companies to find a proper field, say in a great metropolis like London, or in the different towns and shires of the provinces. There is room for more than one telephone company within the limits of the three kingdoms, and perhaps it is fortunate for the purses of the people that there is.

No doubt, if there were no danger of unreasonable charges being made, a single company working all the exchanges would be preferable to several, especially if town were linked to town by telephone. And here we have the most powerful argument in favour of a Government monopoly of telephones, for in the latter case there would be little or no fear of excessive charges being made. The French are far more socialistic in their life than we are, and far fitter for that liberty, equality, and brotherhood which is as yet only marked in paint on their public buildings, but which we are all making for, and hope to carve in the stone itself at some future day. But, on the other hand, a Government monopoly of telephones, in this country at least, would almost certainly be repressive of new inventions, except those developed by the service, and there would, probably, be less of that obligingness forthcoming from the agents of British officialism than the public has a right to expect from the servants of a private company, from which it can withdraw its custom. In France this drawback would not exist, for in that sunny land even Government officials are at times genial and polite.

On the whole we are of opinion that the present state of

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things is the best adapted to this country for the time being. Under the auspices of private companies, especially of rival companies, the introduction of the telephone amongst the people will go on faster than it would if it were in the hands of the Post Office, who would not have the same interest to push it. Moreover, new telephones are more likely to be invented and put in practice. Then when a decided advance has been made in this direction, and the public have become habituated to the new service, the Government may be called upon to step in and take the systems over, just as it did in the case of the telegraphs, but necessarily at a heavy cost.

ON THE THEORY OF MAGNETO AND DYNAMO MACHINES.

XII.

Ohm's Law.

Let us take a given conducting wire and maintain it in a constant condition as to temperature, &c., and suppose that the difference of potential between its ends, and at the same time the current produced in it by such difference of potential, be measured.

Let various E.M.F.'s and the corresponding strengths of current be observed, what is the relation between them?

It will be found that, within the limits of highly accurate experimental error, the two are proportional: in other words,

The current in a given conductor is proportional to the E.M.F. driving it.

This is the empirical law of Ohm.

Put into symbols it is

$$\frac{V - V'}{\gamma} = \frac{E}{\gamma} = \text{const.}$$

The constant is a characteristic of the conductor as long as it remains in the same condition, but it is in all substances a function of the temperature, as well as of other physical conditions—such as hardness, brittleness, and the like.

Electrical conduction through both metals and electrolytes appears to obey Ohm's law. Its singular simplicity, wide applicability, and great accuracy, sometimes cause one to forget that it is a mere empirical statement; and that why it is true, or what is its physical meaning—if, indeed, it be accurately true, as seems probable—we are absolutely ignorant. We may, however, feel pretty sure that its physical meaning is something very important.

Referring back to the dimensions of E and γ in the electro-magnetic system of units, we see that the above constant (their ratio) is a velocity, not a mere unit, and therefore must be expressed, in absolute C.-G.-S. measure, as so many centimetres per second. The name given to this constant is "*resistance*;" and a conductor which permits the C.-G.-S. unit of current to flow through it, when the E.M.F. applied is but a C.-G.-S. unit, would be said to have a resistance of 1 centimetre per second.

Such a conductor would be so massive that five days would nearly elapse before enough heat was generated in it by the unit current (10 webers) to raise a gramme of water 1 degree centigrade. The dimensions of such a conductor would be a slab whose area exceeded its thickness 1,700 times, even if made of pure copper. The resistance of a cubic centimetre of pure copper, at 0°C., is about 1640 centimetres per second.

For practical purposes such a unit of resistance is too small, and electricians have adopted in place of it that which permits a weber of current to flow through it if driven by a volt. This practical unit is called an Ohm, and equals a thousand million centimetres per second.

Joule's Law.

We may now write Ohm's law

$$E = R\gamma;$$

hence the energy of a current $E\gamma t$ (*see* Art. XI.) may be written $R\gamma^2 t$, and this is called Joule's law, because it was discovered by him, experimentally and empirically, before it was perceived to follow as a natural consequence of the doctrine of potential, combined with the fact that $E = R\gamma$.

Notice that $E\gamma$ is the most general expression for the "power" of a current. It includes work done against anything whatever—resistance, chemical action, magnetic fields, &c., &c. $R\gamma^2$ is an expression simply for the heat-generating power of a current in a given conductor, *i.e.*, for the mechanical equivalent of the heat produced per second.

Volt-meter.

Although, as we have said, it is not easy to measure an E.M.F. directly in absolute electro-magnetic measure, yet a high resistance galvanometer, used as a shunt, will enable us to get a determination of it.

Given a thick wire, through which a current is flowing; required to determine the difference of potential between its ends.

Connect to each end one terminal of a galvanometer of high but known resistance, putting, if necessary, also a megohm or two into its circuit as well, so that it shall shunt an utterly inappreciable portion of the current through itself, and not perceptibly disturb the E.M.F. it is used to measure. Then the same difference of potential is driving a current through the galvanometer as through the wire. Observe the current through the galvanometer, and multiply it by the known resistance of its branch circuit, and you have the E.M.F. which is driving the current through the galvanometer, and, therefore, also the E.M.F. acting through the wire.

One cannot ordinarily use standard galvanometers for this experiment, hence the graduation must be empirical; and Ayrton and Perry issue a dead-beat volt-meter, which is just like their large current galvanometer (or Am-meter, as they choose to style it, *see* Art. IX.), only it has much thinner and probably German silver wire, and is to be used, not as a vehicle for the main current, but as a shunt.

Ohm-meter.

To measure the resistance of a conductor in ohms all that is necessary is to measure the current sent through it in webers, and the E.M.F. driving it in volts, and to take their ratio. But an instrument might easily be devised which should give a reading of the ratio at once, without measuring either separately. Thus, let a galvanometer have two coils, one short and thick, the other long and thin. Send the main current through the low resistance one, and it is virtually a weber-meter (or *am*-meter, if it must be so). Shunt a portion of the current passing through the given conductor so that it passes through the high resistance coil instead of the others, and it is virtually a volt-meter.

Now, if the coils be arranged judiciously, and the currents sent simultaneously, it may be possible to cause them just to neutralise each other's effect on the needle, leaving it simply pointing in the magnetic meridian as before.

For instance: let the planes of the two coils be fixed at right angles to each other, with the needle at their common centre; and let them be turned about a common vertical axis until the needle is undisturbed by them—in which position we will say the plane of the thick coil makes an angle, θ, with the meridian. Then, if A and B be the "constants" of the two coils,

$$A\gamma\cos\theta = BE\sin\theta;$$

whence the resistance of the given conductor is

$$\frac{E}{\gamma} = \frac{A}{B}\cot\theta.$$

Whether this is the precise form of the instrument which those indefatigable workers, Messrs. Ayrton and Perry, are now bringing out we are unable to say; but it will be something on this principle.

Observe that resistance may be roughly determined by such an instrument directly in absolute measure, and independently of all "bridge" or other comparison contrivances. Each reading will be a direct absolute determination, though, of course, not one pretending to high accuracy.

We are of opinion that such an instrument, if put in a

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simple and practical shape, would be an immense boon to the practical electrician, and that it would save a great deal of ignorant guesswork and traditional error.

Coulomb-meter.

We suppose this is the place to mention the contrivances which are now necessarily exciting much attention, viz., *quantity* measurers, or integrating galvanometers; some beautiful designs for which Mr. Boys recently exhibited to the Physical Society. But we will postpone their consideration for the present. Suffice it to say that any chemical voltameter is a direct quantity measurer.

Ergometer.

Suppose a thin wire coil is suspended freely inside a thick wire coil, just as the movable coil of an electro-dynamometer is, and that the main current be sent through the thick wire, while the thin wire is used as a shunt. We shall get a deflection or a torsion which will be proportional both to the strength of the current and to the difference of potential between the two points when the shunting takes place. That is, we shall get a measure of $E\gamma$, the *power* of the current in the conductor, between the points of derivation, or shunt points.

Such an instrument has been constructed by Messrs. Ayrton and Perry, and it has been called by Sir W. Thomson, who also invented it a little later, an electrical *ergometer*, because it indicates the number of ergs per second which the current in that part of the circuit is doing.

This is a capital instrument for measuring directly the horse-power of an arc light. Let the current which feeds the arc flow through the thick wire coil, and let the ends of the thin wire coil be joined to the upper and lower carbons. The indication of the instrument, multiplied by the proper constant, gives the horse-power expended in the arc.

The work done in an arc is $E\gamma t$, and can only be expressed as $E\gamma t$. There is here no question of $R\gamma^2 t$, because Ohm's law does not apply to an arc. It scarcely applies to incandescent lights, since their resistance is a function of the temperature, and therefore of the strength, of the current; but to an arc light Ohm's law does not even approximately apply. The value $\frac{E}{\gamma}$ is not constant, and, therefore, the name "resistance" has no proper meaning. It is quite unnecessary to distinguish between opposition E.M.F. and resistance; the product $E\gamma t$ gives the whole work expended on the arc, and this is the mechanical equivalent of the heat produced.

Integrating Ergometers.

When electric currents are supplied to every house, meters will, of course, be necessary, and it is generally supposed that coulomb-meters will be the sort required. Nevertheless, it may be maintained that the more correct measurer would be an *energy*-integrator; for it is the total energy, $\int E\gamma dt$, supplied that the householder ought to pay for, and not the mere quantity of electricity, $\int \gamma dt$. Of course, if the E.M.F. is taken on trust, and assumed to be constant, the latter meter would do; but there is no difficulty in devising a variety of integrating ergometers, and some of them may be practicable instruments, and come into use.

It may, however, be debated which is, after all, the fairer meter; and the question will arise whether, if an accidental local short circuit occurred in a house, the consumer should pay through the nose for what is no good to him (as he would if he paid by quantity), or whether he should only pay for that which was serviceable, as he would more approximately if he paid by energy. The answer seems to depend upon the question at whose door the fault of the accidental short circuit ought to lie. For, if the connections were abreast, as it may be assumed they would be, his accidental short circuit would divert a great deal of his neighbours' currents, and would be wasting a lot of the central energy in disturbing the underground temperature,

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although I have not made a special study of the physiological effects of the electric current in its various forms, nor of electro-therapeutics, yet I should be inclined to quarrel, for two reasons, with your recent article under this heading. First, you do not admit that electricity has any curative properties; secondly, you admit, or seem to admit, that magnetism has *some* physiological action, though "not so energetic" as that of electricity. "If electricity have any curative properties!" Shades of Humboldt and Valli, of Becquerel, Claude Bernard, and Golding Bird, hear that! Have, then, Duchenne and Rémak, Nobili, Marianini, Matteucci and Du Boss-Reymond, Althaus and Garratt, Tripier, Onimus, Hiffelsheim, and Charcot, with all their fellow-workers, failed to establish as a fact the curative action of electricity in any case? Are their labours as futile as would be the endeavour to detect anything electrical in the "electric" stars, lockets, hair brushes, &c., &c., with which we passively allow the public to be beguiled at the present day? I imagine not; I am under the impression that the literature of electro-physiology and electro-therapeutics is about as important, and as worthy of attention, as that of electro-telegraphy. And I am of opinion that those who are versed in the latter might with advantage learn something of the ingenuity and scientific adaptation to be found in many appliances, intended for medical use, which are too often ignorantly classed amongst the catch-pennies so impudently advertised as "honest," and so seldom denounced as dishonest.—Yours, &c.,

DESMOND G. FITZGERALD.

ELECTRIC RAILWAYS.*

BY PROFESSOR W. E. AYRTON, F.R.S.

We have grown so accustomed to the regular announcement, "serious accident on such and such a railway, several passengers injured," that we have almost come to regard railway accidents as inevitable, just as parents mistakingly think the measles and whooping cough necessary accompaniments of childhood. But speed no more means disaster than a densely crowded city means disease. The first effect of overcrowding is undoubtedly to produce fever and other complaints. If, however, the knowledge and practice of the laws of hygiene increase more rapidly than the population of a town, the death rate, as we have seen, diminishes, instead of augmenting. And so it is with locomotion; the stage-coach journeys of our ancestors were slow enough for the most staunch conservative, and yet the percentage of the passengers injured on their journeys was far greater than even now with our harum-scarum railway travelling. The number of passengers has increased enormously, but the safety has increased in an even greater rate. If, then, we can devise methods introducing still greater security, a far larger number of passengers may travel at a far greater speed and with less fear of danger than at present.

Accidents constitute one charge against railway conveyance, but there is another, and that is the cost. Cheap as railway travelling now is, compared with the departed stage coach locomotion, the price of the tickets is still far too high for railways to fulfil, even in a small degree, one of their most important functions, and that is transporting labourers from parts of the country where labour is scarce, to others where it is abundant and labourers in demand.

But how is a happier state of things to be realised? We cannot expect the railway companies to lower their fares merely to benefit humanity. If, however, we can prove to them that the present system of railways is neither the most remunerative to themselves nor the most beneficial to the community at large, we may hope to win the attention of railway directors, whose stock question is, and quite rightly, "Will it pay?"

Those of you who have read the life of Stephenson know what a protracted fight he had to carry one of his most cherished ideas, and that was the employment of a locomotive engine to draw the train, instead of a stationary engine to pull it with ropes or chains. His adversaries saw the disadvantage of adding the weight of the locomotive to the weight of the train, whereas

* Abstract of a Lecture at Royal Institution, March 24th, 1882.

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Stephenson was especially struck with the enormous waste of power in the friction of ropes or chains passing over pulleys. [Experiments were then shown proving, *first*, that the mass of the locomotive necessitated the engine having a greater horse-power to get up the speed of the train quickly as well as a greater horse-power to keep up the speed; *secondly*, that the friction and wear and tear of ropes such as were employed on the London and Blackwall Railway would have been an insuperable hindrance to the development of railways.] From this was deduced that, since in Stephenson's day the only feasible mode of communicating the power of a stationary engine to a moving train was by means of ropes, his decision to adopt the locomotive was perfectly correct at the time it was made.

Attempts have been made to propel trains by blowing them through tubes, or by blowing a piston attached to the train through a tube, but such attempts at pneumatic railways have nearly all been abandoned. The employment of air compressed into a receiver on the train by fixed pumping engines stationed at various points along the line, and employed to work compressed air engines on the carriages has been effected with considerable success by Colonel Beaumont, especially for tram-lines. The weight of the compressed air engine is, however, still very considerable. Any system of pumping water through a pipe and employing the water to work a hydraulic engine on the train is hardly worth considering; seeing that the mechanical difficulties of keeping up a continuous connection between the moving train and the main through which the water is pumped seems insuperable. Gas engines worked with ordinary coal gas, stored, perhaps, under pressure, might be employed on the moving train, but the advantage arising from the absence of boiler and coal would be more than compensated for by the fact that the weight of a gas engine per horse-power developed is so much greater than that of a steam engine. None of these systems, then, of dispensing with a locomotive is by any means perfect, and the success of the recent experiments on the electric transmission of power has turned the attention of engineers to the consideration, whether electricity could not successfully supplant steam for the propulsion of trains and tram cars; whether it could not, in fact, supply an efficient means of transmitting power, the absence of which caused Stephenson to abandon ropes in favour of a heavy locomotive engine.

The whole question, like every similar one, is mainly a question of expense; and what we have to consider is whether electric transmission on the whole leads to greater economy than can possibly be obtained by the employment of any kind of locomotive. The average weight of a locomotive is about that of six carriages full of people; ten carriages compose an ordinary train, hence the presence of the mass of the locomotive adds at least 50 per cent. to the horse-power absolutely necessary to propel the carriages alone, and therefore at least 50 per cent. to the amount of coal burned. But there is another most serious objection to the engines, perhaps even more important than the preceding. The heavy engine passing over every part of the line necessitates the whole line and all the bridges being made many times as strong, and therefore many times as costly, and the expense of maintenance consequently also far greater, than if there were no locomotive. And it is not possible to make the engine much lighter; for it would not have then sufficient adhesion with the rails to be able to draw the train; in fact, you cannot diminish the weight as long as the train is propelled with only one or two pairs of driving wheels as at present. The employment of electricity, however, will enable a train to be driven with every pair of wheels, just as the employment of compressed air enables every pair of wheels to brake the train.

To propel a train we must either utilise the energy of coal by burning it, or use the energy possessed by a mountain stream, or the energy stored up in chemicals, and which is given out when the chemicals are allowed to combine, or we must employ the energy of the wind. Practically we employ at present only the first store for propelling railway trains—the potential energy of coal; and that is to a great extent the store on which we shall still draw, even when we employ electric railways. For experience shows that, with the modern steam-engine and dynamo, at least one-twentieth of the energy in coal can be converted into electric energy; and that this is at least twenty times as economical as the direct conversion of the energy of zinc into electric energy by burning it in a galvanic battery.

But, it may be asked, did not Faraday's discovery, in 1831, that a current could be produced by the relative motion of a magnet and a coil of wire, settle this point half a century ago? Theoretically—yes; practically, however, the problem was very far from being solved, because the dynamo-machine was very unsatisfactory, and it was not until Pacinotti, in 1860, solved the problem of obtaining a practically continuous current from a number of intermittent currents, and until Gramme, about 1872, carried out Pacinnoti's idea in the actual construction of large working machines, that the mechanical production of currents became commercially possible. [Experiments were then shown illustrating the complete electric transmission of power, a gas engine on the platform giving rapid motion to a magneto-electric machine, and the current thereby produced being sent through an electro-motor at the other end of the room, which worked an ordinary lathe.]

In electric transmission of power there is not only waste of power from mechanical friction, but also from electric friction arising from the electric current heating the wire, through which it passes.

It was then explained and demonstrated experimentally that this latter waste could be made extremely small by placing so light a load on the electro-motor, that it ran nearly as fast as the generator or dynamo, which converted the mechanical energy into electric energy; actual experiments leading to the result that for every foot-pound of work done by the steam-engine on the generator, quite $\frac{7}{10}$ of a foot-pound of work can be done by the distant motor.

One reason why electric transmission of power can be effected with so little waste is because electricity has apparently no mass, and consequently no inertia; there is, therefore, no waste of power in making it go round a corner, as there is with water or with any kind of material fluid. Another reason why electro-motors are so valuable for travelling machinery is on account of the light weight of the motor. Experiment shows, that one horse-power can be developed per 50lb. of dead weight of electro-motor; a result immensely more favourable than can be obtained with steam, gas, or compressed-air engines.

In addition to the loss of power arising from the heating of the wires by the passage of the current, there is another kind of loss that may be most serious in the case of a long electric railway, viz., that arising from actual leakage of the electricity due to defective insulation. To send an electric current through a distant motor, two wires, a "going" and "return" wire must be employed, insulated from one another by silk, gutta percha, or some insulating substance; and if the motor be on a moving train, there must be some means of keeping up continuous connection between the two ends of the moving electro-motor and the going and return wire. The simplest plan is to use the two rails as the two wires, and make connection with the motor through the wheels of the train; those on one side being well insulated from those of the other, otherwise the current would pass through the axles of the wheels, instead of through the motor. It is this simple plan that is employed in Siemens' Lichterfelde Electric Railway, now running at Berlin; the insulation arising from the rails being merely laid on wooden sleepers having been found sufficient for the short length, a mile and a half. The car is similar to an ordinary tram car, and holds twenty passengers. [Photographs were then projected on the screen of this and of the original electric railway laid by Siemens in the grounds of the Berlin Exhibition of 1879, and exhibited in 1881 at the Crystal Palace, Sydenham.] It was explained that on this latter railway, which was 900 yards long, both the ordinary rails were used as the return wire, and that the going wire was a third insulated rail rubbed by the passing train. [Photographs were then projected on the screen of Siemens's electric tram car at Paris, used to carry fifty passengers backwards and forwards last year to the Electrical Exhibition.] In this the going and return wires were overhead and insulated, connection being maintained between them and the moving car by two light wires attached to the car, and which pulled along two little carriages running on the overhead insulated wires, and making electric contact with them. [Experiments followed, proving that although two bare wires lying on the ground could be quite efficiently employed as the going and return wire, if the wires were short and the ground dry, the leakage that occurred if the wires were long and the ground moist was so great, as to more than compensate for the absence of the locomotive.] Consequently Professor Perry and myself have for some time past been working out practical means for overcoming these difficulties, and we have arrived at what we hope is an extremely satisfactory solution. Instead of supplying electricity to one very long, not very well insulated rail, we lay by the side of our railway line a well insulated cable, which conveys the main current. The rail, which is rubbed by the moving train, and which supplies it with electric energy, we subdivide into a number of sections, each fairly well insulated from its neighbour and from the ground; and we arrange that at any moment only that section or sections, which is in the immediate neighbourhood of the train, is connected with the main cable; the connection being of course made automatically with the moving train. As then leakage to the earth of the strong propelling electric current can only take place from that section or sections of the rail which is in the immediate neighbourhood of the train, the loss of power by leakage is very much less than in the case of a single imper-

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fectly insulated rail such as has been hitherto employed, and which being of great length, with its correspondingly large number of points of support, would offer endless points of escape to the motive current.

Dr. Siemens has experimentally demonstrated that an electric railway can be used for a mile or two; Professor Perry and myself, by keeping in mind the two essentials of success, viz., attention to both the mechanical and electrical details, have, we venture to think, devised means for reducing the leakage on the longest railway to less than what it would be on the shortest.

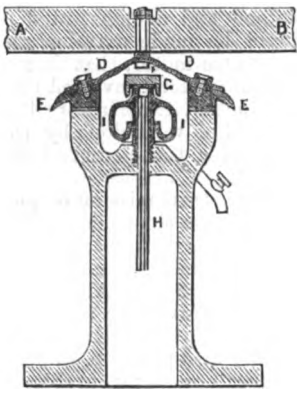

FIG. 1.—One Form of Contact Box.

For the purpose of automatically making connection between the main well-insulated cable and the rubbed rail in the neighbourhood of the moving train we have devised various means, one of which is seen in Fig. 1.

A B is a copper or other metallic rod resting on the top of and carried by the boxes, is merely an insulated bar under the carriages, and which, by its motion, bends slightly forwards and downwards an elastic fork K K on the top of the contact box, and so brings F into contact with G.

[Other diagrams were explained, illustrating modifications of the contact boxes, in one case the well-insulated cable being carried inside the flexible rail, which then took the form of a tube, in another case the cable being insulated with paraffin oil instead of with gutta percha or india rubber, &c.]

The existence of these contact boxes at every 20 to 50 feet also enables the train to graphically record its position at any moment on a map hanging up at the terminus, or in a signal box or elsewhere, by a shadow which creeps along the map of the line as the train advances, stops when the train stops, and backs when the train backs. This is effected thus:—as the train passes along, not only is the main contact between F and G automatically made, as already described, but an auxiliary contact is also completed by the depression of the lid of the contact box, which has the effect of putting, at each contact box in succession, an earth fault on an insulated thin auxiliary wire running by the side of the line. And just as the position of an earth fault can be accurately determined by electrical testing at the end of the line, so we arrange that the moving position of the earth fault—that is, the position of the train itself—is automatically recorded by the pointer of a galvanometer moving behind a screen or map, in which is cut out a slit representing by its shape and length the section of the line on which the train is, as shown in Fig. 3. In addition, then, to the small sections of 20 feet or more into which our auxiliary rubbed rail is electrically divided, there would be certain long blocked sections one mile or several miles in length, for each of which on the map a separate galvanometer and pointer would be provided. [Experiments were shown of the system of graphically and automatically recording the progress of a train.]

In the preceding systems there are several contact-boxes in

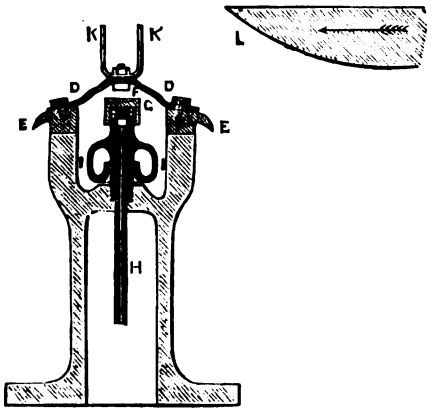

FIG. 2.—Another Form of Contact Box.

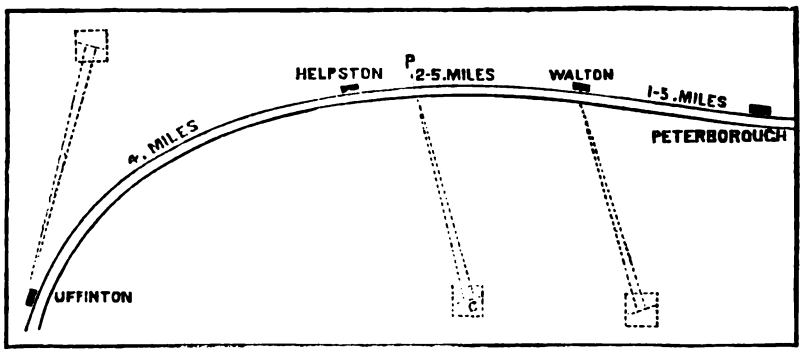

FIG. 3.—Showing Method of Graphically Indicating Positions of Trains.

fastened to a corrugated tempered steel disc, D D (of the nature of, but of course immensely stronger than the corrugated top of the vacuum box of an aneroid barometer), and which is carried by and fastened to a thick ring, E E, made of ebonite or other insulating material. The ebonite ring is itself screwed to the circular cast-iron box, which latter is fastened to the ordinary railway sleepers or buried with only the top above ground. The auxiliary rail A B and the corrugated steel discs D D are sufficiently flexible to allow of two or more of the latter being simultaneously depressed by an insulated collecting brush or roller carried by one or all of the carriages. Depressing any of the corrugated steel discs brings the stud F, which is electrically connected with the rod A B, into contact with the stud G, electrically connected with the well-insulated cable.

As only a short piece of the auxiliary rail A B is at any moment in connection with the main cable, the insulation of the ebonite ring E E will be sufficient even in wet weather, but the insulation of G, which is permanently in connection with the main cable, must be far better. For this purpose we lead the gutta percha, or india rubber covered wire H coming from the main cable through the centre of a specially-formed telegraph insulator, and cause it to adhere to the inside of the earthenware tube forming the stalk. And as, in addition, the inside of each contact box is dry, a very perfect insulation is maintained for the lead coming from the main cable. Consequently, as all leakage is eliminated except in the immediate neighbourhood of the train, this system can be employed for the very longest electric railways.

Fig. 2 shows a modification of the contact box when the auxiliary rail L, instead of extending all along the line and being each section of the insulated rubbed rail, and several sections of the insulated rail in each section of the line blocked, but in the next system the rubbed rail is simply divided electrically into long sections, each of as great a length as the particular system employed to insulate the rubbed rail will allow. In this case we arrange that the electric connection between the main cable and the rubbed conductor shall be automatically made by the train as it enters a section, and automatically broken as the train leaves a section. The model before you is divided into four sections, and you see from the current detectors that as the train runs either way it puts current into the section just entered, and takes off current from the section just left.

But more than this, not only does the train take off current from the section A when it is just leaving it, and entering section B, but no following train entering section A can receive current or motive power until the preceding train has entered section C. [Experiments were then shown proving that with this system a following train could not possibly run into a preceding train even if the preceding train stopped.] Now why does the following train when it runs on to a blocked section pull up so quickly? The reason is because it is not only deprived of all motive power, but is powerfully braked, since when electricity is cut off from a section the insulated and non-insulated rail of that section are automatically connected together, so that when the train runs on to a blocked section the electro-motor becomes a generator short circuited on itself, producing, therefore, a powerful current which rapidly pulls up the engine.

[Experiments were then shown of the speed with which an electro-motor, which had been set in rapid rotation and then

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deprived of its motive current, pulled up when its two terminals were short circuited.]

Whenever, then, a train, it may be even a runaway engine, enters on a blocked section, not only is all motive power withdrawn from it, but it is automatically powerfully braked, quite independently of the action of the engine driver, guard, or signalman. No fog, nor colour-blindness, nor different codes of signals on different lines, nor mistakes arising from the exhausted nervous condition of overworked signalmen, can with this system produce a collision. The English system of blocking is merely giving an order to stop a train; but whether this is understood or intelligently carried out is only settled by the happening or non-happening of a subsequent collision. Our Absolute Automatic Block acts as if the steam were automatically shut off and the brake put on whenever the train is running into danger; nay, it does more than this—it acts as if the fires were put out, and all the coal taken away, since it is quite out of the power of the engine-driver to restart his train until the one in front is at a safe distance ahead.

But all trains will undoubtedly be lighted with electricity. Must, then, the train be plunged into darkness when it runs on to a blocked section to which no electric energy is being supplied? No! If some of the electric energy supplied to the train when it is on an unblocked section be stored up in accumulators, such as are at present used on the Brighton Pullman train, the lamps will continue burning even when the train has ceased to receive electric energy from the rubbed rail.

When, then, we commit the carrying of our power to that fleet messenger to which we have been accustomed to entrust the carrying of our thoughts, then shall we have railways that will combine speed, economy, and safety; and last, but not least to us Londoners, we shall have the entire absence of smoke, the presence of which nearly causes the convenience of the Underground Railway to be balanced by the pernicious character of its atmosphere.

THE EFFECT OF TEMPERATURE ON THE ELECTRICAL RESISTANCE OF MIXTURES OF SULPHUR AND CARBON.*

Within the last fifteen months I have from time to time made a number of experiments with the object of ascertaining whether sulphur could, under any circumstances, be made to exhibit the remarkable property possessed by selenium, and in a smaller degree by tellurium, of having its electrical resistance diminished by the action of light. Amongst other things, the effect was tried of mixing it with graphite. The sulphur was heated to a temperature a little above its melting point, 115deg. C, and when quite liquid a small quantity of tolerably pure powdered plumbago was stirred into it. The liquid mixture was then poured into moulds and allowed to cool quickly. Sticks or plates were thus produced of a substance which in general appearance closely resembled crystalline selenium, its surface being dull and slate-coloured, and its fracture metallic, not unlike that of cast iron.

A short stick of this substance was fitted with platinum-electrodes (platinum wires being made red hot and pressed into the two ends), and was joined up in circuit with a Leclanché cell and a reflecting galvanometer. The spot of light was brought to the zero point at the middle of the scale by means of a magnet, and the sulphur rod exposed to the radiation of a gas flame which was held within a few inches of it. The spot at once began to move, showing a considerable change in the resistance of the rod; the gas flame was extinguished, and the spot slowly returned to zero.

Upon examination, however, it appeared that the behaviour of this sulphur rod differed from that of crystalline selenium in two important particulars. In the first place, the change of resistance was clearly an effect not of light but of temperature. Burning magnesium produced no greater change than the gas flame when held at the same distance. Sunlight was found to have a powerful effect, which was scarcely diminished when the light was caused to pass through red glass; but blue glass or a cell containing water formed an effectual screen. A black-hot poker or even the warmth of the finger caused a greater deflection than a strong light which was too far removed to heat the rod sensibly. Now, in the case of selenium, though it is, of course, true that absorption of radiations is followed by a rise of temperature, particularly when such radiations belong to the red or infra-red parts of the spectrum, it is not, I think, the fact that such rise of temperature is in any way connected with the remarkable variation of the resistance under the influence of light, which, owing to the invention of the photophone, has lately attracted so much attention. The electrical effects of radiation are, in this case at least, no more due to rise of temperature than are its chemical effects.

The second point in which the sulphur rod appeared to differ from selenium was in the *direction* of the change which the radiation of the gas-flame produced, the galvanometer showing that its resistance was increased instead of being diminished, as might have been expected. Here, however, upon the supposition that the effect is due to heating, the behaviour of the sulphur is really similar to that of selenium; for my experiments (agreeing with those of Professor Adams) show that at ordinary temperatures slight heating is always accompanied by considerably increased resistance.

After numerous trials in order to ascertain what proportions of sulphur and graphite yielded the greatest sensitiveness to heat it appeared that a mixture containing 20 parts by weight of sulphur to nine of graphite was the most suitable. It was also found to be more sensitive when cooled rather quickly than when cooled slowly, though its specific resistance (which is always high) was generally lower in the latter case.

In order that the peculiar property of the substance may be exhibited in the most effective manner it is necessary to arrange it in thin films, so that a large surface relatively to the bulk may be exposed to the action of radiation. This was at first done by spreading it as thinly and evenly as possible upon plates of glass or mica, having tinfoil electrodes at each end. An objection to this method, however, was the enormously high resistance which it involved, amounting sometimes to several hundred thousand ohms. I, therefore, adopted the device which I generally use in the construction of selenium cells, and which is a simple modification of the method originally proposed by Dr. Werner Siemens. Two wires, preferably of platinum, are wound parallel to each other and very close together around a slip of mica, care being taken that the wires do not touch each other at any point. A film of the melted mixture is spread evenly over one surface of the mica, and the wire electrodes are thus connected with each other through half their entire length by a series of very narrow strips of the sulphur mixture.

The resistance of a sulphur "cell" constructed in this manner was 9,100 ohms at a temperature of 14deg.C. The cell was slowly heated in an air bath, and the resistance measured at almost every degree. The following table sufficiently indicates the rate at which the resistance increased :—

Temperature. Deg.C.	Resistance. Ohms.
14	9,100
19	11,400
25	13,700
30	16,700
35	20,600
40	26,900
45	34,000
50	42,900
55	57,000

Thus at 55deg. the resistance of the cell was more than six times as great as at 14deg.

Upon another occasion the cell was raised to a much higher temperature. No measurements were, however, made with the bridge, the cell being simply connected with a battery, and a galvanometer and the deflections noted from time to time. After passing 55deg. the resistance increased with great rapidity, until at a temperature of 100deg. it was sensibly infinite, there being no movement of the spot of light when the circuit was opened with a key. Immediately after passing 100deg. the resistance began to fall even more quickly than it had risen. The deflection at 105deg. was the same as that at 85deg., at 110deg. the same as at 65deg., at 114deg. the same as at 50deg., and at 115deg. the same as at 35deg. The spot of light now became so unsteady (probably in consequence of the melting of the cell) that it was not possible to carry the experiment further.

A mixture has also been prepared in which lamp black was used instead of graphite, but very few experiments have yet been made with it, and the results have not been uniform. At ordinary temperatures it generally behaves like the graphite mixtures, but its temperature of maximum resistance is probably lower than 100deg. In one case, indeed, in which the proportions were 8 parts of sulphur to one of lamp black, the resistance was found to be greatest at 15deg. (530,000 ohms), any change in the temperature, whether in the direction of heat or cold, producing a decrease. But with this single exception, every specimen of the mixtures, whether made with graphite or lamp black, has at ordinary temperatures been found to have its resistance increased by heat.

At first sight this appears to be a very paradoxical phenomenon. It is now generally admitted that the resistance of graphite and other forms of carbon is diminished by heat, and it is also commonly believed that a rise of temperature invariably causes a decrease in the resistance of insulators such as sulphur. The compound of sulphur and carbon with which we have to do is certainly only a mechanical mixture (for no chemical combination could be formed at a temperature of 150deg., which is never exceeded in making the preparation), yet the effect which heat produces upon it is exactly opposite to that produced upon each of its constituents.

Some experiments were made in order to determine the effect of heat upon the resistance of carbon and sulphur separately, but although in the case of sulphur some unexpected results were obtained nothing whatever was observed which would *per se* account for the variations of resistance in the sulphur and carbon mixtures.

I believe that the true explanation is a very simple one. The mixture does not consist of a uniform structureless mass of sulphur, having particles of carbon imbedded in and completely surrounded by it; it is, in fact, an aggregation of little crystals of sulphur with carbon packed between them like mortar between bricks. The conduction thus takes place entirely through the carbon particles, which may be considered as extending in a series of chains from end to end of the mass. Under the influence of heat both the sulphur and the carbon expand, but the expansion of the sulphur is nearly ten times as great as that of the carbon, the nett result being that the carbon particles are drawn apart, and have fewer points of contact with one another. The number of complete chains is thus diminished, and the resistance of the mass consequently increased.

It is stated in Balfour Stewart's "Treatise on Heat" that sulphur after being heated to a certain temperature contracts instead of expanding. This would account for the fact that after being heated to a certain point the resistance of the mixture begins once more to decrease; for the carbon particles would when the sulphur contracts be brought together again.

Several experiments corroborate this explanation of the variation of the resistance. Thus a mixture was made containing three parts of shellac to two of graphite. Though the proportion of carbon was larger than in the sulphur experiments, its resistance was found, as it was expected to be, infinite, for the structureless shellac penetrated between and completely surrounded the carbon particles. A mixture of paraffin and graphite gave the same result.

A short rod of the usual sulphur and graphite compound (twenty parts to nine) was fitted with platinum wire electrodes, and its resistance in the air at 17deg. was found to be 3,170 ohms. The rod was immersed in tur-

* Abstract of a Paper read before the Physical Society on March 25th, 1882, by Mr. Shelford Bidwell, M.A., LL.B.

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pentine at the same temperature, and its resistance almost immediately went up about 800 ohms, and in five minutes it was somewhat higher. Though this result did not at first appear to be easily intelligible, it is fully explained by supposing that the liquid penetrated between the sulphur crystals and surrounded the carbon particles. In order to increase the effect the beaker of turpentine containing the rod was placed under the receiver of an air-pump and the air exhausted. After it had remained for a quarter of an hour in a vacuum air was admitted, and another quarter of an hour was allowed for the action of atmospheric pressure. At the expiration of this time the resistance of the rod was found to have increased to 15,600 ohms, about five times as great as it was originally. A similar result was obtained when olive oil was used instead of turpentine, though, owing to the greater viscidity of the oil, the effect was not quite so marked.

Lastly, since the behaviour of the sulphur and graphite mixture under the influence of heat seemed, like that of the microphone, to depend upon the interaction of contiguous particles of carbon, it was expected that one of the sulphur cells made as before described might be used as a telephone transmitter. This upon trial was found to be the case. The sounds reproduced in the receiving telephone were, with sufficient battery power, about as loud as when a good Bell telephone was used as a transmitter, and the articulation nearly as distinct. No experiments whatever have yet been made with the view of developing this property, and there can be little doubt that it is capable of extension. It is not impossible that a transmitter constructed upon this principle might be found to be of practical value; and in appearance, at least, it would differ entirely from anything previously made.

The sulphur cell might also, perhaps, be used as a thermoscope, being more sensitive than an ordinary thermopile, and, at the same time, simpler and easier to construct.

It has recently been proposed to use a mixture of sulphur and graphite for making cheap resistance boxes. It is needless to point out that the great sensitiveness of this compound to small changes of temperature renders it very unsuitable for such a purpose.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

A meeting of this Society was held on the evening of the 23rd ult. at the Institution of Civil Engineers, Great George-street, Westminster. Colonel Webber presided, and there was a large attendance. After the usual formal business had been disposed of,

The CHAIRMAN referred to the guarantee fund which had been raised in connection with the British section of the Paris Exhibition last year. The whole of the charges of the British section were met by the exhibitors themselves. The guarantee fund was administered by commissioners. The amount subscribed or guaranteed was about £1 each, of which 12s. 6d. had been called up; and after defraying all expenses there was a balance which the guarantors had offered to the Society with the following resolution:—"That the remaining surplus of the guarantee fund of £110 be handed to the Society of Telegraph Engineers and Electricians, to whose exertions and co-operation much of the success attending the British section is due, with a request that they will devote it to a fund for the purpose of presenting an annual premium for papers read before the Society, the conditions of which the subscribers to the guarantee fund leave to the Society, but with the suggestion that such premium shall have some title which will associate it with the Paris Exhibition of 1881."

A vote of thanks having been passed to the guarantors,

The CHAIRMAN called on Professor A. E. Dolbear, of Tufts College, Boston, Massachusetts, who had offered a paper on the telephone.

Professor DOLBEAR, who was warmly received, observed in commencing his remarks, that, in the attempt which he was about to make to show them something concerning the development of a new system of telephonic communication, he had thought it would be better at the outset to go hastily over the history of electric telephony. Of course they were, he knew, all more or less familiar with the main points, but he had thought that if he devoted a little time to it, it might refresh the memory of some of them, and would certainly make more clear whatever differences there were between the ordinary system of the telephone, and that of which he was about to speak. Among the earliest attempts to transmit sound through the agency of electricity, the first he knew of was that which was made by Dr. Page, of Salem, Massachusetts, somewhere about 1837. After illustrating on the black board Dr. Page's device, he stated that the cause of the sound which it gave out they all understood to be molecular disturbance. The sound, no doubt, from Dr. Page's bar was sufficiently loud at times to be heard at considerable distances, but he was not aware that Dr. Page made any attempt to transmit sound in any other way than that described. Nothing but a certain definite pitch could be transmitted by this device. The next attempt was that made by a man named Farrar, living in the town of Keene, in Southern New Hampshire, who proposed at first to make a kind of electric telephone, by which sounds of different pitches might be transmitted. For his device Mr. Farrar employed an electro-magnet with a vibrating armature. Continuous sounds were produced with a suitable transmitter, for which he employed a system of vibrating reeds. Having shown the action of this device, he stated that by its means Mr. Farrar was able to transmit tunes, and did so. After that attempt it occurred to him that it ought to be possible to transmit the human voice. He spent a little time in thinking over the problem, but did not succeed, and after receiving a discouraging reply from an eminent scientific man to whom he had communicated his idea, he finally abandoned the attempt. The subsequent work belonged, perhaps, first to Helmholtz, who employed tuning forks in connection with electro-magnets to reproduce sound at a distance. Afterwards came the attempt of Philip Reis, who, it seemed, undertook by himself to solve the problem of transmitting articulate speech. It was known that a sound of definite pitch could be reproduced at distant places, and certain other points (which the lecturer explained) were generally known. It was also common knowledge—though this had been denied—that difference of contact made a difference in the current of electricity. Anyone who had ever set up a battery knew that his first instruction was to make his connections good. Why? Because, if he did not his current was weakened. The material which Mr. Reis employed for his varying contact was platinum. After referring to several devices, made by Mr. Reis for transmitters, some of which he stated were exhibited at the last Paris Exhibition, the lecturer alluded to the receivers invented by Mr. Reis. He first employed a straight bar of iron, similar to that of Dr. Page, surrounded by a coil of wire. There was no defect in it, so far as the principle was concerned, for obtaining the reproduction of articulate speech, but the result obtained from it by Mr. Reis was very meagre. The whole thing was mounted on a box and set on a table, evidently with the expectation of being able to hear such an instrument talk as loudly—make as loud sounds—as the ordinary telegraph instruments made in those days. It would not do it, nor would any instrument yet invented. Mr. Reis afterwards made another receiver which embodied a different device altogether. He invented other instruments, one of which was an electro-magnet, in which, instead of using the molecular motion of the magnet for his sound-producing machine, he employed the vibratory motion of an armature to effect the same thing. Mr. Reis was, of course, in this case using induction. This was used in 1863. Summing up what Mr. Reis had done, the lecturer observed that he invented a transmitter which would vary the current of electricity, depending altogether on the varying rate of pressure brought about between two conducting surfaces when the surfaces were vibrated, and as he (the lecturer) had said before, whether or not there was break of contact under such conditions as these depended simply on the amplitude of the vibration of the membrane. As he himself could testify, having made many experiments of the kind, he knew that the instrument would talk well. Mr. Reis's transmitter, therefore, would transmit, and his receivers would receive, because in principle they were all right, the one depending on molecular work and the other on the inductive vibratory action of the armature. He should allude to that thereafter as Reis's system to distinguish it from other systems he should speak of. In 1876 Professor Bell brought forward another system quite distinct from this. Professor Bell proposed—and he (the lecturer) believed that he was the first in the world to do so—to speak to the armature of a magnet with the expectation that some one else listening to the armature of another magnet in the circuit would be able to hear what was said. His device they were all acquainted with, but the lecturer exhibited it in one of his drawings behind the lecture table. In this case, when the two electro magnets were included in the same circuit with the battery, any motion of the armature of the one would vary the current that was on the line, because an electromotive force would be induced on the line which would traverse that circuit. This was a new system entirely distinct from the other. There was, also, another improvement on that, which was to dispense with the battery and electro magnets, and employ permanent magnets in their place. That condition was represented in his drawing No. 3. It was an invention of his own in 1876, but with the intrument as it was at that time its action was very limited. Under certain conditions it could be used for distances of 15 or 20 miles, but it was not reliable or efficient for long line work. It therefore became necessary very soon to find some means for making the telephone a more practical instrument. It did not seem possible to make the electro-magnet arrangement, or even the permanent magnet arrangement any more efficient than it was. It was therefore necessary to look after some more efficient transmitter. Mr. Reis's original device was reverted to, and many attempts were made to improve his transmitter or find a substitute for it.. And now Mr. Edison proposed to use plumbago, and afterwards lamp black, encased in a short cylinder, and the vibratory movement of a diaphragm upon them was to subject either the plumbago or the lamp black to a varying degree of pressure; and Mr. Edison found, or thought he found, that subjecting them to pressure in that way would increase and decrease the resistance of the carbon. Afterwards Professor Hughes discovered that gas carbon, when in an unconstrained state, was as efficient, or more efficient, than any other substance hitherto appropriated to that use; and now, when the gas carbon was made to take the place of the platinum in Mr. Reis's instrument, we had one of the most efficient transmitters yet invented. In his No. 4 drawing they found the identical instrument invented by Mr. Reis in all its features, excepting that carbon was used as a substitute for platinum. It was now coupled up with the magneto telephone, and was known as the present Bell system. It was the original Reis system *plus* the permanent magnet. A current of electricity was capable of doing a great many kinds of work. It would make an electro-magnet, and do many other things—heat a wire, move a frog's leg, and vary friction between moving surfaces. From this latter principle, as they knew, Mr. Edison had invented an instrument which was known as the motograph originally, and the motophone when applied to telephonic purposes. There was another device which, while appearing to be somewhat the same, was otherwise, and was worked on another principle altogether. He then gave an illustration of the rotophone, the invention of himself, and explained its working. Coming to the particular telephone which he had to exhibit, he first observed that those who had experimented with so-called static electricity, who had ever charged a Leyden jar, might have noted that whenever the jar was charging or charged, there was a sound of cracking or snapping, and more or less noise continued till it was discharged. That a charged body was capable of doing that had been known for a long time. The first experiment known in which the effects of condensers in any other form than those of Leyden jars were observed, was one by Sir William Thomson, about 1863, in which he made what was called an air condenser in connection with some submarine cables; and he observed that, as often as a condenser was charged or discharged, it produced a sound, and the sound, Sir William Thomson thought, appeared to come from the air between the two parts of the condenser. Afterwards Dr. Wright coupled up a couple of pieces of silver paper back to back, and connected them with the terminals of a secondary coil, and with a Reis transmitter, and found that by charging and discharging a condenser in that way he had sounds reproduced loud enough to be heard in a hall of considerable size. He had never heard, however, that articulate speech was ever attained with this apparatus of Dr. Wright. After that, Mr. Varley employed condensers of considerable capacity, and by charging and discharging obtained sounds. He (the lecturer) was not aware of the specific device used or the result obtained, but he did not understand that articulate speech was obtained from the arrangement referred to, or that it was even attempted. Although his (the lecturer's) present apparatus was in some measure affected by similar conditions, yet it was not true that he had worked up to it from that direction. It occurred to him at one

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time that if he should pass a varying current of electricity through a substance which the electricity would decompose, and the decomposition of that substance would result in the liberation of gaseous material which should occupy a larger space than the original material before it was decomposed, then he would have the means of setting up vibrations by means of the gaseous product. He illustrated the device on the black board, and explained its working and the success attending it as a speaking telephone, and remarked that at one time, when he was at work on the experiment, he found that from some reason the liquid in the interior had leaked out; but he was still able to hear when there was nothing but air in it. From such conditions as these he devised the present instrument, the features of which he proceeded to explain. Before giving them an exhibition of what it would do, he wished to say a few words about the electrical conditions present in it. It had been known for a very long time (perhaps from the earliest days) that an electrified body would attract any other body in its neighbourhood. Suppose the existence of a wire which came from some source of electricity, a body attached to it would be electrified, and if another body, say a pith ball, was placed near it, it would be attracted to it. This was a case of action at a distance, a physical condition which was interesting for many reasons. A great deal was involved in that kind of action which physicists would have to look after. To get the maximum amount of sound out of a device of the form of a condenser, it was an essential condition, sonorous vibrations occurring with such great rapidity in articulate speech, that the plates in the telephone should not be capable of absorbing to any appreciable extent the electrical condition. There was, therefore, a limit to the magnitude of the plates and of the material used. He had worked from plates of numerous sizes, but although the instruments he was then exhibiting were tolerably small, he had found that the small ones were just as efficient as any he had been able to make, in the way of loudness and distinctness of articulation. A few words about the new (the different) conditions at the transmitting end. In diagrams 1, 2, 3, and 4 he had only drawn the necessary conditions—he had put in nothing else. With No. 5, which represented his present instrument, it was absolutely essential that he should have electromotive force, for that was the working factor in his instrument. There were two or three ways in which he could use a transmitter, which he proceeded to explain, with the results attending them. Proceeding to exhibit the working of the instrument, he called attention to the fact that he had set up twelve instruments in the room, all in connection with the same circuit, and he had a transmitter in that room, and a second transmitter in another room. The length of wire was not very great, but it was sufficient to show the action of his instrument. He wanted to show that it was a working instrument, and that the battery and all was included in the box which he held. From another room an assistant counted ten, which was heard distinctly in all parts of the room, and the same result followed when "God Save the Queen" and "Yankee Doodle" were whistled. The services of a cornet-player were afterwards brought into requisition with equal success, the audience in the lecture room hearing distinctly. The lecturer, continuing, said: Here is an instrument which has but a single plate in it, not two (as the previous one had). If this is simply connected with the wire there is no special difficulty in hearing what is said in this instrument.

The CHAIRMAN, at the request of the lecturer, listened at the instrument whilst the assistant in the other room counted ten, and afterwards stated: The articulation is quite perfect, but not so loud as the other.

Professor DOLBEAR: I have gone one step further. Here is my device, and I have found that it is not necessary to have it attached to the circuit at all. It having been disconnected,

The CHAIRMAN again listened to the assistant counting, and stated that he heard "perfectly."

Professor DOLBEAR observed, after the experiments, that he thought it might be well if he said a few words as to some of the advantages of the system, and why he had described it as a new system. In Reis's system the electricity was transformed into magnetism, which was transformed into the vibratory motion of the plate. There were two transformations in that case. In this (the lecturer's) case the electrical transformation was but a single one. The electrical condition itself was immediately transformed into the vibratory motion of the plate, without the intermediary of magnetism. The simplicity of the instrument was very great indeed. He could hardly conceive how it was possible to make anything more simple, it consisted of two plates in proximity to one another mounted in a convenient handle. He had heard it fifty feet from the terminal. It was only necessary to bring wires anywhere in the neighbourhood, and as many as were present who were provided with receivers could hear all that was said. On account of the electromotive force employed the matter of resistance did not enter into the question as a factor as in cases where a current of strength was necessary. The cost of the apparatus was about the same as the other systems. As to what it would do, he had had a line set up between his lecture room and his residence—a line of about half a mile long. For two years it had been in regular use, and when he left home it was going as well as it did at first; and the cell which he put in a year ago last May had not been touched to be taken out, but a little water to replenish the evaporated parts had been put in a couple of times. He had used the instrument on tolerably long lines—10 miles, 40 miles, and on two occasions 260 miles, on the telegraph wire of the Rapid Telegraph Co. between Boston and New York. On the first of these occasions it was very rainy, but he had no trouble in hearing—there was no material difference between that and the other occasion when it was fine and dry. Beyond this he had not tried what the instrument was capable of doing. He concluded by thanking them for their attention, and expressing his willingness to show any of them the instrument, when they had leisure, in Queen Victoria-street.

Mr. WILLOUGHBY SMITH stated that it was a curious coincidence that he was present on that occasion. At the early part of the year he offered a paper to the society on induction, but the Society was so full of papers that no arrangement was made. He had been very much struck with what Professor Dolbear had brought forward as regarded speaking at a distance. He had been experimenting lately in that way, and he would be happy the next day to exhibit the result at his place in Wharf-road, City-road. He had constructed out of fine copper wire something resembling a magnified cobweb, in the circuit of which were ten cells and a sensitive microphone. If that were placed in the centre of a room, any person in any part of the room applying a telephone to his ear, would hear distinctly any sound given out by the microphone. This was rather a curious fact, and only showed how possible it was for two brains to be working on the same idea.

Mr. ADAMS expressed the delight with which they had listened to the lecture, and afterwards alluded to the modification made, he believed, in 1864 by Mr. Yeates, in Reis's instrument. A history of the telephone had been given by Professor Dolbear, and he thought it well that Mr. Yeates's name should be connected with it.

The CHAIRMAN observed that it was five years ago since they heard Professor Bell describe what to most of them was then a novel idea, which had produced all over America and Europe an industry, the extent of which very few of them could yet compute, and as to the future extent of which none of them had an idea. Since then they had heard in that Society very little of the matter, but now, after five years, their brother from America had brought the same subject before them with fresh interest, fresh ideas, and fresh prospects for the future. In the laboratory of the Society would be found all the papers and pamphlets which bore on the subject. In the pamphlets of Professor Barrett, of Elisha Gray, and in the paper read by Professor Bell before the Society, would be found a mass of reading which, after what Professor Dolbear had said, would be full of interest. The question of priority of invention or ideas was not one without interest to the Society, but it was not one for them to decide on. They had been only glad to hear Professor Dolbear's announcement, and they only hoped it would be the means of placing telephony at the free disposal of every human being. He called on Mr. Preece to move a vote of thanks to the lecturer.

Mr. PREECE re-echoed the remark made by Mr. Adams as to the delight with which they had listened to the clear explanation by Professor Dolbear of his views. There was nothing more marvellous than the wonderful universality of the power which electricity possessed of making everything speak [laughter]. As to the question of priority of invention, it would be unfair and unjust for any one to express an opinion, particularly as he might be subjected to the inconvenience of a subpœna. If, however, this principle was to be made a monopoly, he contended that there was something very rotten in our patent laws, and something that required improvement. Mr. Willoughby Smith had alluded to two brains working simultaneously in one direction, but it was a still more curious fact that three brains had been working in this particular direction, the third being that of Professor Hughes. Nearly two years ago Professor Hughes showed in his rooms to Mr. Spottiswoode, Professor Stokes, himself, and others some very curious experiments, and they were exactly in the direction that Professor Dolbear had shown them that night, and to which Mr. Willoughby Smith had referred—that sounds were conveyed or repeated at extreme distances. They stood away from Professor Hughes's instrument, and they heard everything that went on. Professor Hughes ought to have written a paper, and brought the matter before the Royal Society; but he would let them into a little secret. Professor Hughes was an obstinate man. He showed his experiments to the gentlemen mentioned; but while Professor Hughes maintained that the effect was due to conduction, they maintained that it was due to induction. Because Professor Hughes could not convert them he had never yet written the paper for the Royal Society, and the result was that his labours had lain hidden. There was another matter that Professor Dolbear's experiments had brought up. The phenomenon he had converted into a telephone was far more than the mere attraction and repulsion of electrified masses. There was, as Professor Dolbear had said, something behind it for physicists to examine and new fields to explore. Most of them had studied the works of their great master and apostle, Faraday, and they all knew how he sought to discover an electro-tonic state—a peculiar state of matter which existed between positive and negative discharge due to induction and other causes. He thought if Faraday had been alive he would have had in Professor Dolbear's telephone a stimulus to help him to discover his electro-tonic state. All who had worked in this field must have seen how wonderfully prolific were the discoveries of philosophers when they came into the hands of practical men, and how they were fostered and encouraged by the applause which they had given to Professor Dolbear. He concluded by moving a hearty vote of thanks to the lecturer.

Professor CAREY FOSTER having briefly seconded the motion, it was carried unanimously.

Professor DOLBEAR, in reply, said he would not trouble them with another speech, but would merely express the gratification which their reception had given him.

LECTURES AT THE CRYSTAL PALACE.

An additional lecture on "The Electric Transmission of Power" was given on Wednesday evening by Professor Sylvanus P. Thompson, of University College, Bristol, at the Crystal Palace. The lecture, an abstract of which is given below, was in continuation of the four previous ones, abstracts of which have been given in our pages.

The amount of power developed ceaselessly by natural forces—winds, waves, waterfalls, tides, and sun-heat—exceeds enormously all the power that man extracts from coal; and of this natural power almost all runs to waste. Even the coal that we burn as a source of power is almost all wasted. Our steam engines utilise only one-tenth part of the total energy of the coal that they consume, the other nine-tenths being wasted. This waste is the more serious as the supply of our coalfields is being rapidly exhausted. The other natural sources of power are allowed to run to waste for want, firstly, of some means of laying hold of or utilising them; secondly, of some means of storing the intermittent supplies of energy which they furnish; and thirdly, for want of adequate means of transmitting the energy thus stored from the place where it is produced to the place where it is wanted to be applied. To utilise such natural power, windmills, watermills, turbines, and tide-mills are necessary. The lecturer instanced the little town of Schaffhausen as utilising the power of the falls of the Rhine at that place to drive turbines, the power thus obtained being distributed through the town to the various workshops and factories by a system of overhead shafts and belts. The ingenious model tide-mill exhibited at the Crystal Palace by Messrs. Liardet and Donnithorne showed how tidal power might be utilised. The lecturer

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had claimed that in the tidal flow of the channel of the Severn there was wasted at least five times as much power as would suffice to do all the work for which coal is burned in England. Dr. Siemens had shown in 1877 that in the Falls of Niagara alone there was more power running to waste than would be required to do the whole mechanical work of the world. The intermittent character of all these so-called natural forces necessitated a means of storage. The mechanical hydraulic accumulator of Sir W. Armstrong, though an admirable invention, could not answer except for supplying machinery that was only used at intervals. It was, moreover, impracticable to transmit power to a long distance by means of water-pressure in pipes. Ropes, belts, and shafts, too, as a means of transmitting power were impracticable and uneconomical for distances exceeding a few yards, except in the limited cases of vertical hoisting. No one would think now of driving a carriage or tramcar along rails even for a single mile by means of a rope. It was the wear and tear of ropes that made Stephenson insist on driving trains by locomotive engines, though their weight added 50 per cent. to the load that had to be carried, and therefore added 50 per cent. to the consumption of fuel. That a mere wire would suffice to transmit power electrically was not known to Stephenson. Electricians had indeed known for 50 years that an engine could be made to work by electric currents. They had known for nearly a century that such currents might be carried to any desired distance without diminution of strength by means of insulated metal wires. But it was only within the last ten or twelve years that the invention of the dynamo-electric machine had rendered economically practicable the production of electric currents on a large enough scale to be of importance as a source of mechanical power or a means of conveying it from one place to another; and it was only within the last five or six years that they had begun to realise what an enormous power might be transmitted to great distances through a comparatively thin wire. Experiments were here shown illustrative of the action of the dynamo-electric machine used as a generator in producing electric currents at the expense of mechanical power. The reversibility of these machines was then adverted to and illustrated. All or any of the many different kinds of dynamo would serve as a motor, and when supplied with a strong electric current from some independent source could be set in rotation and be made to do mechanical work for which steam or other power would otherwise be required. Electric motors were shown in the Palace sawing planks, driving sewing machine, turning lathes, and working printing presses and other machinery. They might be utilised to work elevators such as Hopkinson's electric lift, and even, as Mr. Latimer Clark had shown, might be taken down by a diver to aid him in recovering a sunken ship. More recently electric tramways and railways had been devised, the great advantage of such systems being the relatively very light weight of the engine, which was less than 50lb. of dead weight per horse-power, far less than any steam or gas engine. The difficulty in all the suggested systems of electric railways was that of getting the electric currents conveyed without loss into the engine. Every one knew that in conveying electric currents two wires were necessary—a "leading" wire and a "return" wire," though the earth might be used for a return wire if desired. But the leading wire must be very carefully insulated to prevent the currents leaking out of it before they reached the engine. The difficulty lay in securing this necessary insulation along a long line. In Siemens' electric railway at Lichterfelde, near Berlin, the lines of rails were used to convey the currents, one rail being the "leading" wire, the other the "return" wire. Into the "leading" rail the currents were pumped by the generator or dynamo, at one end of the line. They travelled along the rail till they came to the point where the engine was. Here they entered the wheel of the engine and passed up into the coils of the motor, descended to a wheel on the other side, and so completed the circuit home through the "return" line. In Siemens' electric tramway at Paris, the "leading" wire was an overhead line, with which the moving tram car kept itself in communication by two light wires, which were tied to little frames that ran along the overhead wires on wheels. For long lines of railway, however, there would be great difficulty in maintaining the "leading" wire from leakage while the latter was in perfect communication with the engine. Professors Perry and Ayrton had lately made a most ingenious proposal to divide the leading line, through which the engine drew its supply of currents, into a number of separate sections, each insulated from the other, each section being supplied with the current by means of a buried cable, with which it was put into temporary contact only when the train was on that section. These contacts being automatically made by the moving train itself, there was the remarkable additional advantage in this system that it would work as an absolute and automatic block system, in which it would be impossible for one train to follow another on the same section. Professors Perry and Ayrton proposed to do away with a special engine, and to drive the train by fixing a motor upon the axis of each pair of wheels on each carriage. Mr. Edison had also constructed experimental electrical railways; the first had worked at Menlo Park two years ago. He had just finished a new electric-locomotive engine, resembling outwardly the American type of locomotive, minus the smoke stack. Storage batteries had also been suggested for propelling tram cars, a tram car actuated by Faure's accumulators being actually at work at Leytonstone. The lecturer doubted, however, whether the constant wear of transport would be economical in the case of accumulators. The very facility with which electricity could be transmitted by wires rendered its porterage by carrying heavy cells superfluous. Returning to the question of the distribution of power by electric wires, the lecturer pointed out that the reason why coal had been used rather than wind or water as a source of power had been because of its superior portability and reliability, not because of its superior cheapness. Wind and water power were uncertain, and could not always be had on the spot when they were wanted. But if these kinds of power could be rendered reliable by the use of accumulators, and distributed economically without loss in the form of electric energy, then coal, though more portable, would no longer be so cheap or so convenient a source of power. Steam power could not from its very nature be distributed from a central station to a whole town, and small steam engines were not nearly so economical as large ones. On the other hand, nothing was easier to distribute than electric power. You had only to carry a leading wire from the central works where the currents were generated to the workshop where it was wanted, and small electric motors were just as economical as large ones. Once let there be a great central electrical supply—as there must be if whole towns were to be lit up by electric lights—and the distribution of power electrically must inevitably follow, as it would undoubtedly supersede steam in small workshops, if not in large ones too. When he said that in the near future electricity was to be our servant to do the hard work of the world in the place of our present servants, coal and steam, he meant what he said. Our stores of coal were rapidly diminishing, and the steam engine was the most wasteful way of using the limited store that remained to us. The first and most important result of an electric power supply would be to render small motor machinery economical. It would, therefore, undoubtedly tend to foster small independent workshops in all the constructive industries. For the last hundred years the use of steam had produced a concentration and centralisation of labour in large factories, which, while advantageous to production, had disturbed the preceding order of things and had exalted the capitalist while destroying the independence and freedom of labour. The social and economic result of the introduction of electric power would tend to restore the former condition of things while still enhancing the productive power of the country. If electric power was as cheap on the small scale as on the large, concentration of workmen in a barrack-like factory would be unnecessary. Home work would be fostered, and the profits of labour would be more directly at the disposal of those who earned them. Small capital would have a fairer chance than now, and large capitalists would have a less chance of still further inflating their position at the expense of labour. The workman would be less at the mercy of the capitalist or of a trade combination, being more independent; and industrial crises would become less frequent. Thus the economic result of the electric distribution of power would tend toward the material prosperity of a greater number, in the reorganisation of labour which it would entail.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The first ordinary general meeting of the Consolidated Telephone Construction and Maintenance Company (Limited), was held at the offices, No. 6, Lombard-street, on the 24th of March. Sir Julius Vogel, K.C.M.G. (the chairman), presided.

The SECRETARY (Mr. Charles Curtoys) having read the notice convening the meeting,

The CHAIRMAN said: In the notice which was sent round to the shareholders, it was explained to them that the only business we proposed should be transacted at this meeting was that the meeting should be adjourned till some date in April. The notice explained how that was the case. The operations of the Company end on the 31st of March, but in the Articles of Association it was prescribed that, unless otherwise determined, the annual general meetings should take place in March. Clearly we are not in a position to give you a statement of your accounts before the end of the month, and it will take some three weeks after the end of March before we can give you a statement of accounts and a report. I therefore propose that this meeting stand adjourned to April 24. By that time we shall be able to make up the accounts and send a report round to the shareholders, and at the adjourned meeting it will be proposed to you to fix that the annual general meeting shall take place between the 15th April and the 15th of May. I am sorry that any of you have been troubled to attend to-day. We thought in the notice we sent round that the matter was sufficiently explained to save you the trouble of attending. There really is no business that we can transact to-day except to adjourn the meeting.

Mr. P. CARNEGY, C.I.E., having formally seconded the motion for adjournment,

The CHAIRMAN said: At the adjourned meeting there will, no doubt, be a much larger attendance of shareholders, and we shall hold it at the City Terminus Hotel. We shall take care to advertise and send the shareholders information as to the time of the meeting, which we cannot tell now.—The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES MARCH 29.		BUSINESS DONE WEEK ENDING MARCH 29. Highest.		Lowest	
Anglo-American	53¼,	53½	.....	53½	.....	51½
Do. Preferred	83,	84	.....	84	.....	81½
Do. Deferred	24½,	24½	.....	25	.....	23
Brazil Submarine	11½,	11½	.....	11½	.....	11 1-16
Cuba	8,	8½	.....	8½	.....	8½
Do. Preference	15½,	16½	.....	—	.....	—
Direct Spanish	6,	6½	.....	6½	.....	6½
Do. Preference	15½,	16½	.....	—	.....	—
Direct United States Cable	11½,	11½	.....	11½	.....	11 1-16
Eastern Telegraph	10,	10½	.....	10½	.....	10
Do. 6 per Cent. Preference	12½,	13	.....	12 13-16	.....	12 13-16
Do. 5 per Cent. Debentures, 1899	102,	107	.....	—	.....	—
Eastern Extension	11½,	11½	.....	11½	.....	11½
German Union	9½,	9½	.....	9½	.....	9½
Globe Telegraph and Trust Company.	6½,	6½	.....	6½	.....	6 3-16
Do. Preference	12½,	12½	.....	12½	.....	12½
Great Northern	12½,	13½	.....	13½	.....	12 9-16
Indo-European	27½,	28½	.....	—	.....	—
Mediterranean Extension	1½,	2½	.....	—	.....	—
Do. Preference	8½,	9	.....	—	.....	—
Reuter's	12½,	13½	.....	—	.....	—
Submarine	260,	270	.....	—	.....	—
West India and Panama	1½,	2½	.....	2	.....	1 1-16
Do. 1st Preference	8,	8½	.....	8½	.....	7½
Western Brazilian	8½,	8½	.....	8½	.....	8½
West. Union 7 per Cent. 1st Mortgage	124,	129	.....	126	.....	126
Do. 6 per Cent. Sterling Bonds	102,	105	.....	104	.....	104

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1½	.....	1 7-16	.....	1 7-16
Oriental	½,	½	.....	½	.....	7-16
United Telephone	13½,	13½	.....	13½	.....	13½

ELECTRIC LIGHT.

Eastern Electric Light and Power	½,	½	.....	--	.....	—
Electric Light and Power	½,	1	.....	15-16	.....	½
Anglo-American Brush	9½,	10½	.....	9½	.....	9½

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SLIP

CABLE REPAIRED.—The cable between Fao and Bushire, interrupted about a month ago, is now repaired.

"THE JOURNAL OF THE TELEGRAPH."—This American publication will for the future appear monthly instead of twice a month.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY. — The traffic receipts of this company for the week ended March 31 amounted to £3,402.

CRYSTAL PALACE.—The directors have added a new division for electro-mechanics to the Crystal Palace School of Practical Engineering.

THUNDERSTORM.—The western counties were on Monday last visited by a severe thunderstorm, accompanied by hailstones of unusual size.

DOMESTIC ELECTRIC LIGHTING.—It is stated that Mr. Richardson, M.P., intends introducing the electric light into his new mansion at Yarm.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March amounted to £48,824, against £51,206 in the corresponding period of 1881.

GLOBE TELEGRAPH COMPANY.—The directors of this company announce interim dividends of 3s. per Preference share and 2s. per Ordinary share for quarter ending April 18th next.

ELECTRIC LIGHTING AND PLACES OF AMUSEMENT.—The Paris Hippodrome is brilliantly illuminated by the electric light, and the use of the sliding roof for ventilation is now rendered unnecessary.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended March 31 are £3,915, as compared with £2,645 in the corresponding period of 1881.

THE EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March amounted to £33,677, against £29,661 for the corresponding period of 1881, being an increase of £4,016.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for March were £19,680, and for the period 1st January to 31st March, £53,640, as against £53,224 in the corresponding months of 1881, and £47,935 in 1880.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending April 1 were £2,212, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE EDISON LIGHT IN BERLIN.—It is announced that the National Bank of Germany has just concluded the preliminaries of a contract with the agents of Mr. Edison for illuminating certain public buildings with his incandescent lamps.

THE SWAN LIGHT AT HUDDERSFIELD.—According to *The Review of Gas and Water Engineering* the attempt to light Messrs. Brooke, jun., and Company's woollen manufactory by means of the Swan system has not yet proved satisfactory.

NEW TELEGRAPH STATION IN BRAZIL.—The Western and Brazilian Telegraph Company notify that they have opened a station at Ceara, in Brazil, the charges to which will be eleven shillings per word from all stations in England.

ELECTRIC LIGHT FOR COLERAINE (IRELAND).—The Town Commissioners of Coleraine are thinking of lighting the town by the electric light, the necessary current being generated by means of the water power which is available at the Cutts.

SHEEP KILLED BY LIGHTNING.—In the neighbourhood of Inverkeithing, a few days ago, a flock of sheep were seen to be struck by lightning. Five of their number were found dead, and it was noticed that their necks had the appearance of being singed.

"THE AGE OF ELECTRICITY."—The first of a series of articles bearing this title, contributed by Mr. W. H. Preece, F.R.S., appears in this month's *Time*. Mr. Preece is always lucid, and the style he has here adopted is eminently suited for magazine readers.

EXMOUTH AND THE ELECTRIC LIGHT.—In response to the remonstrances of the Exmouth Local Board the directors of the Exmouth Gas Company have agreed to withdraw from their Bill, now before Parliament, those clauses relating to lighting by electricity.

ELECTRIC LIGHT ON STEAMBOATS.—There is every probability that the company plying steamboats on the Rhine will shortly attempt to light both shores of the river ahead by means of the electric light. This for the benefit of sight-seers travelling at night time.

ELECTRIC LIGHT AT TURIN.—The *Lampe Soleil* has been used with success to light the Portico of the Theatre Royal at Turin. This lamp is a semi-incandescent one, the light being derived from two or more carbons abutting on a marble block, the latter being raised to incandescence by the heat of the arc.

"THE TELEPHONE AND TELEPHONE EXCHANGES."—At the meeting of the members of the Manchester Association of Employers, Foremen and Draughtsmen, held on March 25th, a paper on the above subject was read by Mr. Joseph Poole, of the Lancashire and Cheshire Telephone Exchange Company.

VESSEL FIRED BY LIGHTNING.—The barque "August," laden with cotton, when 150 miles from Fryingpan Lighthouse, was, on the 16th ult., struck by lightning, and her cargo set on fire. Fortunately she was fallen in with by a steamer, and towed back into port, with the cotton, however, still burning.

THE TELEPHONE IN SPAIN.—The Director-General of the Spanish Post Office has prepared a measure for the establishment and working of a telephonic system in Spain. The State telegraph lines are also being put in communication with the railway stations, as in other countries; but their arrangement will not be open to the public until July 1 next.

THE HAMMOND ELECTRIC LIGHT COMPANY.—Writing to *The Engineer* in reference to its recent account of the Hammond exhibits, this Company state that the 64 lights now running at the Crystal Palace require exactly the same labour as the lesser number named in *The Engineer*, and that to work this number the estimate should be reduced by £127 15s. for labour.

PRIVACY OF TELEGRAMS.—With reference to the correspondence in the public press relating to the contents of a telegram addressed by Colonel Fred. Burnaby to Mr. T. Wright having been divulged, Mr. Fawcett states that the Post Office has no powers in respect to the secresy of tele-

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grams sent through the Submarine and other foreign telegraph companies.

THE ELECTRIC LIGHTING, CONTRACT, AND MAINTENANCE COMPANY.—The directors of this company, at the recommendation of numerous and influential applicants for shares, announce their intention immediately after allotment to call a general meeting of shareholders with a view to the subdivision of the shares into shares of £5 each, upon which not more than £2 10s. will be called up.

THE ELECTRIC LIGHT IN PARIS.—*The Times* Paris correspondent, writing on the 3rd inst., says:—"People have been puzzled for the last two nights by the absence of the electric light in the Avenue de l'Opéra, and the miserable appearance of the three-burner gas-lights which have taken its place. The contract with the Jablochkoff Company had expired, but the Municipality agreed to-day to renew it for three years."

ELECTRICAL RAILWAY IN AUSTRIA.—A project for an electrical railway between Moedling, near Vienna, and Vorderbrühl, is about to be submitted to the Minister of Commerce. A committee, including the mayor of the above town and the managing director of the Imperial Southern Railway Company, have recently inspected the route of the proposed railway, and pronounced the project to be practicable.

HIGHGATE AND THE GAS COMPANIES.—All over Highgate—and not at Highgate alone—the consumers of gas are complaining of the bad light and great increase in their gas bills. At the union infirmary the excess in consumption is recorded as over a quarter of a million feet during the past three months, though there has been no corresponding excess of light. The board of guardians are therefore about to invite tenders for electric lighting.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting will take place at 25, Great George-street, S.W., at 8 p.m. on Thursday, April 13th, when papers will be read as follows:—"Description of a Form of Battery of Low Internal Resistance," by F. Higgins, member; "Tests of Incandescent Lamps, with Special Reference to the Decrease in Resistance of the Carbon with an Increase of Electromotive Force," by Andrew Jamieson, member.

TELEGRAPH CLERKS' GRIEVANCES.—A meeting of the Bristol telegraph clerks, numbering nearly 100, has been held in that town to protest against the inequalities of the revision scheme of the Postmaster-General, especially as to the way in which it had been administered in Bristol—ignoring, as it did, the claims of telegraphists of long service, and placing above them in position and pay postal clerks of from three to five years' service. It was resolved to memorialise the Postmaster-General.

BRIGHTON AND ELECTRIC FIRE ALARMS.—The Watch Committee of the Town Council have accepted an offer by Mr. Volk, of Brighton, to place his fire alarms in the Royal Pavilion, and to connect the same with the police-station at the Town Hall, and, on behalf of the United Telephone Company, to connect the Town Hall, the Pavilion, and the Volunteer Fire Brigade Station by telephone, on condition that the wires are carried underground, and that all expenses are paid by Mr. Volk and the Telephone Company.

THE ELECTRICAL POWER STORAGE COMPANY.—This new company was registered on the 21st ult. with a capital of £800,000, in £10 shares, to work the patents of Messrs. Sellon, Volckmar, and Swan, relating to secondary batteries, and also to carry on the business of electricians and electrical, mechanical, and chemical engineers, and of workers and dealers in electricity, motive power, and light. The first subscribers include Sir Daniel Cooper, Bart.; Col. F. G. Stuart, Mr. William Ladd, Mr. W. M. Bullivant, Mr. C. Dorman, and Mr. F. Green.

THE BELFAST TELEGRAPH OFFICE.—It appears that up to the year 1879 the clerks at this office were enjoying privileges in the matter of annual leave superior to those prevailing at similar offices elsewhere, but that on its discovery all new entrants to the service had to submit to the regulation period. This grievance was, of course, the subject of a parliamentary interrogation the other evening, but as the Postmaster-General was able to assure the House that nobody had been deprived of anything that he had hitherto enjoyed, rightfully or not, Mr. Biggar—the questioner in this instance—kindly allowed the business of the House to proceed.

MR. EDISON.—The second number of *Celebrities of the Day*, a monthly magazine of contemporary biography, contains an account of Thomas Alva Edison. According to this authority, the American inventor is of Dutch descent, some of his family having emigrated from Holland to the United States in 1730. His father is still living at the ripe age of three score and ten, and is to all appearance likely to count as many years as his father and grandfather, who attained respectively the ages of 102 and 103. Our readers will be surprised to learn that Mr. Edison is extremely deaf. He has two children, who are named, the one Dot and the other Dash, but of what sex our biographer does not reveal.

ELECTRIC AND GAS LIGHT.—A correspondent of the *Journal of Gas Lighting* takes exception to the data in respect to electric and gas lighting given in our last issue, p. 319. He says:—"In the article in question 32 electric lamps are put against 500 gas lamps; that is to say, nearly 17 gas lamps for one arc lamp. It will be readily seen and acknowleged that 17 gas lamps consuming five cubic feet per hour would be much more efficient for the spreading or diffusion of light than one arc light. The above numbers of lamps are for five miles, and five miles, or 8,800 yards, ÷ 32 gives 275 yards between the arc lights; while five miles, or 8,800 yards, ÷ 500 gives 17·6 yards between each gas lamp. A town lighted with gas lamps consuming five cubic feet per hour is tolerably well lighted when the lamps are 34 yards distant from each other, so that the comparison is giving two lamps in the place of one, thus making the cost of gas lighting appear double what it ought to be."

ELECTRIC LIGHT IN THE CITY.—At the recent meeting of the Court of Common Council Mr. Felton said that the electric lighting in No. 1 District (the Brush light) had been supplied at about the same price as gas, in No. 2 (the Lontin light *sic*) at about twice the cost of gas, and in No. 3 (the Siemens light) at about $3\frac{3}{4}$ the cost of gas. On the last occasion he stated that the Brush Company had supplied the electric lighting for less money than the cost of gas. About £40, he believed, was the difference. Since then the company had sent in a contract which would bring up the price to about £120 more than gas. The Siemens Company also contemplated increasing their estimate to five times the cost of gas in the same area. With regard to a better light being obtained by the use of gas on an improved system, as in Fleet-street and elsewhere, he might say that the cost of the gas in Fleet-street was over four times the cost of the Brush system of electric lighting. We have inserted the *sic* above, as we believe it should read "the Weston light."

EDISON ELECTRIC LIGHT COMPANY.—This company is

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formed on terms of an agreement of the 18th February between Thomas Alva Edison, Drexel Morgan and Co., Egisto Paolo Fabri, Grosvenor Porter Lowrey, and the Right Hon. E. P. Bouverie and others to acquire the whole of the patents taken out for the United Kingdom by Mr. Edison in relation to the application of electricity or magnetism as a lighting, heating, and motive agent. Registered on the 15th ult.; capital £1,000,000, in 50,000 A and 50,000 B shares of £10 each. The A shares will be entitled to a preferential accumulative dividend of £5 per cent. per annum on the amount paid up. The consideration is that a sum not exceeding £30,000 in cash be paid to Messrs. Drexel, Morgan, and Co., and further, the allotment to Mr. Edison of one full-paid B share for every £10 capital paid up or credited as paid up in respect of the A shares. The subscribers each take 500 shares:—Right Hon. E. P. Bouverie, Sir John Lubbock, Bart., M.P.; Messrs. Howard Gilliat, W. G. Rathbone, W. Fowler, M.P.; F. J. Bramwell, E. Hibbert Johnson.

The Faure Battery.—Mr. Desmond G. FitzGerald writes to the *Engineer* in answer to a correspondent who doubts the possibility of charging a Faure battery and supplying electric lamps by the same current as follows:—"An electric lamp is an apparatus for the conversion of electrical energy into heat and light; a secondary battery is an apparatus for the storage of electrical energy. Now, there is no difficulty in conceiving of a circuit, traversed by a current generated by a dynamo machine, in which (say) two-tenths of a horse-power, or 6,600 foot-pounds per minute, are absorbed or converted into heat and light by two electric lamps. Nor is there any difficulty in conceiving of a secondary battery which will absorb one-tenth of a horse-power, or store up 3,300 foot-pounds of energy per minute. Now, let it be supposed that the illuminating power of one lamp only is required, and that it is inconvenient to reduce the current—so that the product E I may be halved. Evidently the secondary battery may be substituted for one of the lamps—provided, of course, that due care be taken that it should absorb neither more nor less than one-tenth of a horse-power, so as to leave 3,300 foot-pounds per minute to be converted into heat and light by the agency of the remaining lamp. In this there is no running counter to the principle of the conservation of energy."

Electric Lighting.—In a letter on this subject to the *Western Daily Press*, Mr. F. W. Griffin, of the Bristol School of Chemistry, treats the subject from the point of view of its probable effect on the health of those using it, as contrasted with the evil effects of lighting by gas. He cites Dr. Siemens's paper, read before the Royal Society in March, 1880, "On the Influence of Electric Light upon Vegetation," to prove its beneficial effect on plants, and reasons that "When we consider the close relation, approaching identity, between vegetable and animal life, we can hardly doubt that the above-described vigorous action on vegetation would prove equally beneficial to human health. We have a means of measuring with precision the amount of chemical energy in any kind of light. The same rays which are vital to organic life paint the picture on the photographer's sensitive film. In Kew Observatory their intensity is registered throughout the day by the depth of colour produced on a strip of photographic paper by a patch of light under which it is passed at a speed regulated by clockwork. The brightest gas flame has a barely appreciable photographic power, while an electric light rivals the sunbeam in activity. . . . Electric light is, in fact, artificial daylight, and when its pure radiance has supplanted the sickly glare of gas in our shops, offices, and drawing rooms, we shall virtually be living in a longer day. None would profit more from the change than the toilers in dark and dismal factories. Hence the shareholder in an electric light company, when pocketing the handsomest dividend, would feel that it had been well earned by the practical philanthropy of benefiting his fellows of every degree."

Great Western Electric Light and Power Company.—The prospectus of this company, just issued, states that the company has obtained a concession which has been granted by the Anglo-American Brush Electric Light Corporation (Limited), under which the exclusive rights of use or sale of their dynamo machines and arc lamps, together with a licence for exclusive rights of use or sale of the Lane-Fox incandescent lamp, is secured to the company for a number of counties in Wales and the West of England. The company intends to grant sub-licences to local companies in some cases, but it will also arrange directly with its customers, by establishing depots in various towns for the supply of electricity. £27,750 has been paid for the concession. The Anglo-American Brush Company has granted a special discount of 20 per cent. on machines and lamps to be supplied by it to the Great Western Company. The company intends to supply electricity for any purpose its customers may choose, including storage in secondary batteries. The capital is £250,000, of which £125,000 is to be issued now in £5 shares. Three thousand of these will be issued fully paid up to the vendors, the remainder of the purchase money being payable in cash. It may be mentioned here that a letter was written to *The Times*, shortly after this company had been formed, by the secretary to the Edison Electric Light Company, stating that the Lane-Fox lamp was a "direct infringement of Mr. Edison's patents in this country." This was at once followed by a letter from the secretary to the Brush Company, published in the same paper, denying that there had been any infringement of Edison's patents by Mr. Lane-Fox.

The Government Electric Lighting Bill.—According to the *Standard* the following are the main provisions of the Bill formally introduced into the House of Commons on Monday evening last by the President of the Board of Trade, and entitled a Bill "To facilitate and regulate the supply of Electricity for lighting and other purposes in Great Britain and Ireland." The Board of Trade will be authorised to license any local authority to construct works for the supply of electricity for any public or private purposes. The licence is not to exceed five years, but it may be renewed by consent of the Board of Trade. The "public purposes" are to include lighting any street, place of worship, vestry hall, theatre, or public building. In supplying electricity for "private purposes," that is to say, any purpose whatever to which electricity may be applied, not being a "public purpose," the local authority must treat all persons upon equal terms, and will not be entitled to prescribe any special form of lamp or burner. The Board of Trade may give authority for the supply of electricity by Provisional Order, such order being subject to confirmation by Parliament, and liable to be referred to a Select Committee, and to be modified or repealed by a subsequent Order. Any local authority may take steps to require the Electric Company to sell its undertaking, by giving notice of such intention within six months after the expiration of seven years from the confirmation of the Provisional Order, or within six months of every subsequent period of seven years. Any questions arising between the parties may be decided by the Board of Trade. Power is given to make rules and bye-laws, to authorise local authorities to borrow money, to alter the position of pipes and wires, and to make charges for electricity. The Bill also contains provisions for the protection of the Postmaster-General.

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THE ELECTRIC LIGHT AT NORWICH.

Although the interest in the electric light grows keener every day, it has hitherto been somewhat difficult to answer questions as to cost and horse-power over an extended period of time. In many cases where the electric light has been adopted the question of economy was not so pressing as that of more light or of more suitable light. Norwich, perhaps, next to London, is the best example that we can give of local authorities adopting, testing, and after a long trial extending this light. Messrs. R. E. Crompton and Co., some ten months ago, undertook a contract for lighting a part of this town. The contract has just been renewed for another year. The lighting during the past has been very successful, and we have no doubt the authorities are justified in congratulating themselves and Mr. Crompton on this success.

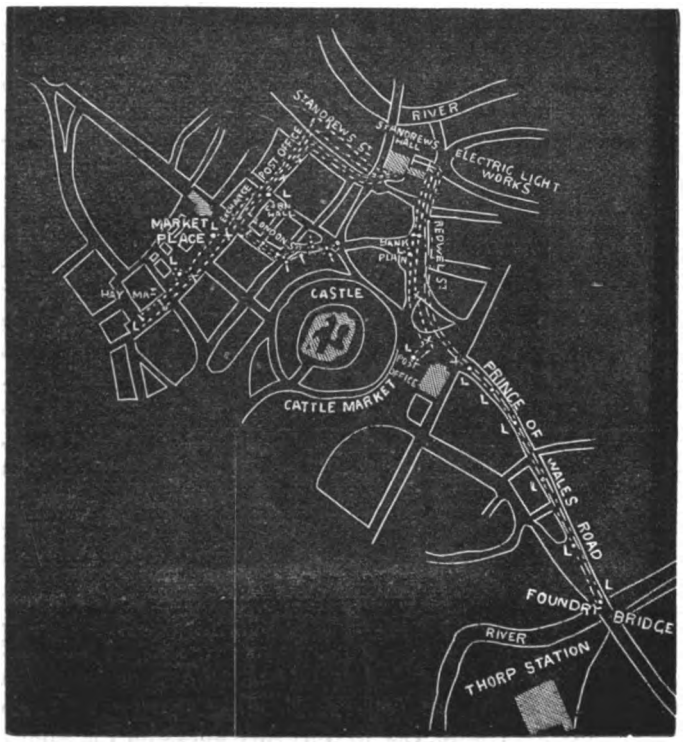

FIG. 1.—Map showing Area Lighted.

The following letter, received by Messrs. Crompton and Co. from the chairman of the Gas and Lighting Committee, may be interpolated here:—

Southwell Lodge, Norwich, March 4th, 1882.

Messrs. R. E. Crompton and Co.,

GENTLEMEN: I forward you by this post a report of our recent council meeting, from which you will observe that your proposal for a continuance of the electric lighting of our market place and other leading thoroughfares for another twelve months was unanimously adopted. Our consulting electric light engineer, J. N. Shoolbred, Esq., of Westminster Chambers, London, who has throughout acted for the corporation in this matter, reports most favourably of your lamps, an opinion fully confirmed by the public after a test of more than eight months. I trust that during the coming year this excellency and uniformity may be maintained, and, if so, I am sure the citizens will welcome a comprehensive scheme for dealing with the whole of the city.—I am, gentlemen, yours faithfully,

(Signed) JOHN WILLIS,

Chairman of the Gas and Lighting Committee.

From what we can gather the lighting committee have for some years had under consideration the improvement of the lighting of the principal parts of the town, and, on the recommendation of Mr. J. N. Shoolbred, C.E., decided to test the capabilities of the electric light. In January, 1881, Mr. Crompton's tender to light the Market Place with two Crompton arc lights for three months was accepted. It will be remembered that in the spring of 1881 the Fisheries Exhibition was opened at Norwich, and the Town Council agreed to lend the lighting plant to the Exhibition Committee. The Exhibition was thus, from its opening to its close, lighted by nine Crompton arc lamps and sixty Swan incandescent lamps, and it is more than probable that its great success was, in no small degree, due to the electric light, for the latter was then, as now, more attractive than fish or fishing appliances.

This use of the plant delayed the lighting of the town, and the regular lighting was not commenced till May. A few weeks after the lamps had begun to work regularly Messrs. Crompton were asked to extend the system, and after trying Swan incandescent lamps and Crompton arc lamps of 2,000 and 3,000 candle-power, it was finally decided to use Weston arc lamps of 800 to 1,000 candle-power, the Crompton lights being almost too powerful for the narrow area to be lighted. As our readers well know Mr. Crompton makes,

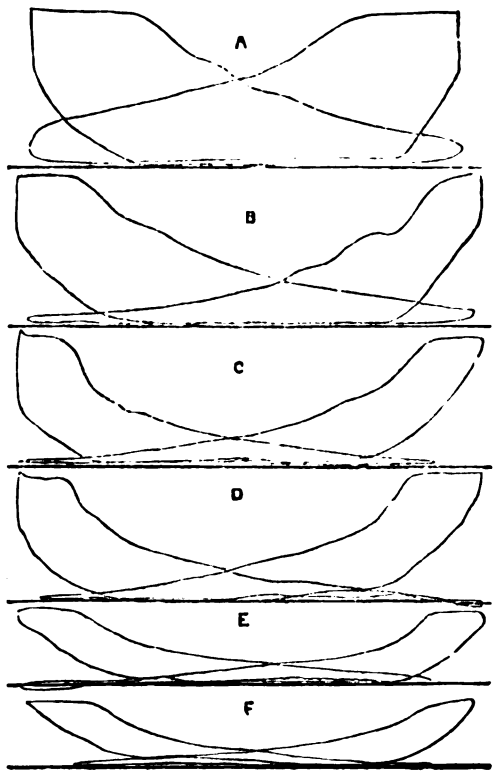

FIG. 2.—Indicator Diagrams.

(A) Revolutions, 139; Pressure, 55lbs.; Spring, 30lbs.; Mean Pressure, 29·5lbs. H.-P. = 20·7.

(B) Revolutions, 141; Pressure, 47lbs.; Spring, 30lbs.; Mean Pressure, 18·75lbs. H.-P. = 13·5.

(C) Revolutions, 140; Steam, 40lbs.; Spring, 30lbs.; Mean Pressure, 13·85lbs. H.-P. = 9·9.

(D) Revolutions, 140; Steam, 40lbs.; Spring, 30lbs.; Mean Pressure, 13lbs. H.-P. = 9·34.

(E) Revolutions, 140; Steam, 25lbs.; Spring, 30lbs.; Mean Pressure, 8·75lbs. H.-P. = 6·25.

(F) Revolutions, 140; Steam, 20lbs.; Spring, 30lbs.; Mean Pressure, 7·75lbs. H.-P. = 5·5.

and generally uses, the Bürgin dynamo, and it was found that seven Weston lamps could be supplied by a four-light Bürgin, through a circuit of No. 8 wire, B.W.G., two miles in length.

The installation, as carried out finally, consists of two circuits, each including three large Crompton lights of 4,000 candle-power each; these light the Haymarket, the Market Place, the Bank Plain, and Post Office Plain, all wide and open spaces; two circuits of Weston lamps, twelve in all, lighting London-street and Prince of Wales-road right down to the railway station; also two Crompton arc lights in St. Andrew's Hall, and fifty Maxim incandescent lamps in the Free Library. The arrangement of the lights will be better seen on reference to the accompanying map (Fig. 1) of the area lighted. The letter L signifies lamp. The results have been exceedingly satisfactory to all parties. The streets are brilliantly lighted, more than double the

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illumination obtainable with gas being given. There has been entire freedom from breakdowns and accidents, and from the contractor's point of view, the cost of maintenance is comparatively light. The generating station is at Elm-hill, in a yard belonging to the city authorities at the back of St. Andrew's Hall. The steam engine is a

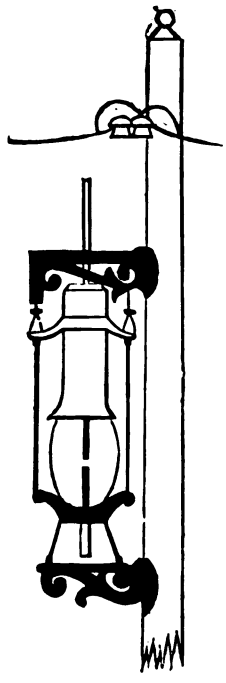

Fig. 3.—Weston Arc Lamp, Post, and Conducting Wire.

double cylinder engine, 20 h.-p. nominal, of the semi-portable type. This drives two lengths of shafting, from which six dynamo electric machines of the Crompton-Bürgin type are worked; four of these drive the fifteen arc lights, which are in regular use in the streets, with one machine as spare, and one for driving the incandescent lamps at the Free Library. We give in Tables I. and II. statements as to the power

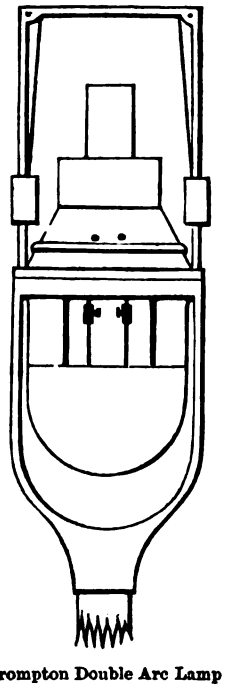

Fig. 4.—Crompton Double Arc Lamp and Post.

absorbed by the various circuits. These have been most carefully compiled from a long series of indicator diagrams taken over extended periods and compared carefully with the coal and water consumption, a record of which has also been carefully kept from the very commencement of the installation. From these tables it will be noticed that the percentage of horse-power absorbed in engine and shafting friction is very considerable, also that the engine is not particularly economical of fuel. The water is supplied by meter,

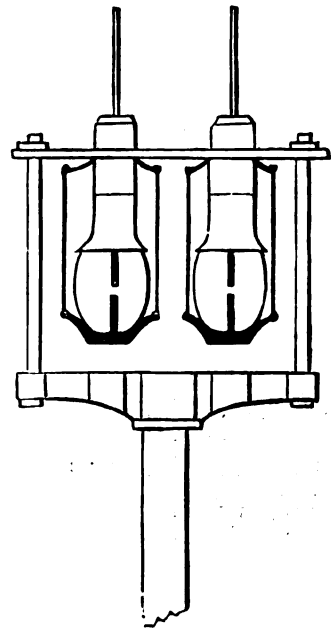

Fig. 5.—Weston Arc Lamps and Post.

and this enables the coal consumption to be compared with the water used. From this it appears that the boiler evaporated about 7·71b. of water per lb. of coal, which was Derbyshire steam coal of fair quality.

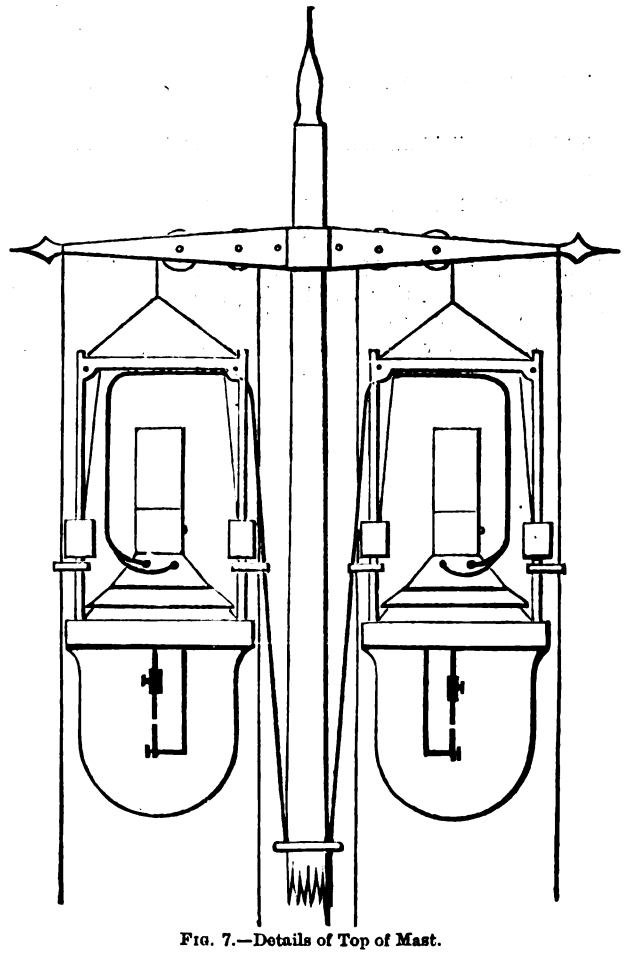

Fig. 7.—Details of Top of Mast.

Fig. 2 gives an illustration of the indicator diagrams referred to. The diagrams are distinguished by the letters A to F, and the data referring to each diagram will be found below immediately after each index letter.

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TABLE I.—*Horse-power Expended.*

—	Total H.-P., as calculated from diagram.	H.-P. absorbed by engine.	H.-P. absorbed by shafting.	H.-P. absorbed by 7 Weston arcs, brushes up.	H.-P. absorbed by 7 Weston arcs, brushes down.	H.-P. absorbed by 3 Crompton arcs market lights.	H.-P. abs. by 2 Crompton large arcs in Bank Plain and Post Office Plain.	H.-P. absorbed by 3 Weston arc lights London-road.	H.-P. absorbed by spare machine.	Indicator diagram.
Engine unloaded	10·34	10·34	...	...	...	...	...	...	...	A
Do. driving shafting only	11·54	10·34	1·20	...	...	...	...	...	...	B
Do. driving 7 Weston arc lights in Prince of Wales-road, brushes up	19·62	10·34	1·20	8·08	...	...	...	...	...	C
Do. do. brushes down	20·58	10·34	1·20	...	9·04	...	...	...	...	D
Do. do. driving 7 Weston arc lights Prince of Wales-road, brushes up, and 3 Crompton market lights..	25·64	10·34	1·20	8·08	...	6·02	...	...	...	E
Do. do. driving 7 Weston arc lights Prince of Wales-road, 3 Weston arcs London-road, 3 Crompton arcs Market Place, and 2 Crompton arcs Bank Plain. Total, 15 lights and one spare machine ...	38· 8	10·34	1·20	8·08	...	6·02	6·81	4·85	1·5	F

TABLE II.—*Working Expenses.*

—	Actual H.-P. used.	Actual H.-P., inclusive of engine and shafting friction.	Coal used per indicated H.-P. per hour.	Water used per indicated H.-P. per hour.	Cost of coal per hour at 14/6 per ton.	Cost of water per hour at 1/6 per 1,000 galls.	Cost of oil, waste, all materials used for repairs, including glass globes, &c., per hour.	Cost of carbons inclusive of waste per hour.	Labour and superintendence, including all labour on repairs.	Total cost per hour in pence.
For each Crompton arc light.....	2·56	3·86	...	...	1·26	·184	·24	·65	·97	3·30
For each Weston arc light.....	1·29	1·94	...	...	·644	·092	·13	·517	·97	2·35
Total.....	25·6	38·8	4·27	32·75	12·88	1·86	2· 5	8·42	14·5	40·16

It should be noted that Messrs. Crompton have their dynamo machines so arranged that by shifting the brushes through a certain arc the current of the machine, and with it the light produced, and power required, can be varied through considerable limits, the variation obtained in this manner amounting to 20 per cent. of the whole light. The brushes are usually set for the smaller degree of light, and the table of working costs has been calculated therefrom, but in cases of foggy weather, or any special cause requiring extra light, the change can be made instantaneously in any one circuit without interfering with any other circuit. The costs in Table II. are divided out as far as coal, oil, water, &c., according to the power used as obtained from Table I. The statements as to carbons used are from actual experience, and the labour is divided equally between the various lights. The net result of this table is to show that the whole installation of 15 lights costs 40·16d. per hour to work it, each Crompton arc light of 4,000 candles costing 3·3d., and each Weston arc of 1,000 candles costing 2·35d. From experience obtained at other installations where they have more economical steam engines at work Messrs. Crompton hope to reduce the coal consumption for the Crompton arc light from 1·26d. to ·51d., which is the cost of coal, for lights of equal size at King's Cross, and that for the Weston arcs from ·64d. to ·26d. It is intended shortly to increase this Norwich installation to a total of 10 Crompton and 30 Weston arc lights, and as the cost of superintendence and labour will remain nearly fixed, the working cost will be greatly reduced. Under these conditions Messrs. Crompton think that the 40 lights will not cost more than 5s. per hour, or at the rate of 1·85d. per hour for the Crompton arcs, and 1·35d. for the Weston arcs. These tables point out very conclusively that any considerable economy to be looked for in these installations must be chiefly sought for in the steam engine and in the reduction of the price for carbons. Any further improvement in the dynamo machines and lamps will have but slight effect in reducing working costs. For instance, if a steam engine using but 2lb. per hour per actual horse-power were put in it would effect a reduction of 10d. in the two items of 14·74d. for coal and water. A reduction of carbon-rods to 1d. a foot would effect a saving of $5\frac{1}{4}$d. on this item, the combined saving reducing the total cost from 40d. to 25d. The wires are throughout No. 8, B.W.G., bare copper wire carried overhead in a most substantial manner on very massive telegraph posts (Fig. 3), and insulated in the usual way by earthenware insulators carried on oak cross-pieces. Figs. 4 and 5 illustrate another method of supporting the lamps. Figs. 6 and 7 show the masts employed for high lights, and the method of hoisting the lamps, &c. In London-street there are no poles, the wires being carried on cast-iron brackets of ornamental design, bolted on to the fronts of the houses. Some of the lamps in this street are carried on the same brackets. The arc lamps are throughout arranged in pairs, so that if any lamp fails to burn properly, or when its carbons are burned out, the second lamp is automatically switched into circuit, so that there is no interruption to the lighting. It seems that the introduction of the electric light has, like every other progress of civilisation, had secondary results, not looked for when first introduced. The extra light in the Haymarket, Market Place, Bank Plain, and Post Office Plain, has been of unexpected service. These open spaces in their former imperfectly lighted condition were the favourite resorts of the idle roughs and loungers and other disreputable characters. The police assert that since the introduction of the electric light it is a comparatively easy task to keep the pavements at the above points clear and orderly. As before stated, Messrs. Crompton now contem-

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plate extensive additions to their plant, and are about to supplement the public lighting by hiring out the current for use with incandescent lamps to such consumers as may care to use it within the area covered by their conducting wires.

The thanks of all electric light engineers are certainly due to Messrs. Crompton for allowing the details of this lighting to be made public. It is only by such self-abnegation that a new industry can prosper, yet many think the experience they gain is more beneficial if kept strictly secret. We may be allowed to doubt this, and to hope that the example of Messrs. Crompton will be imitated.

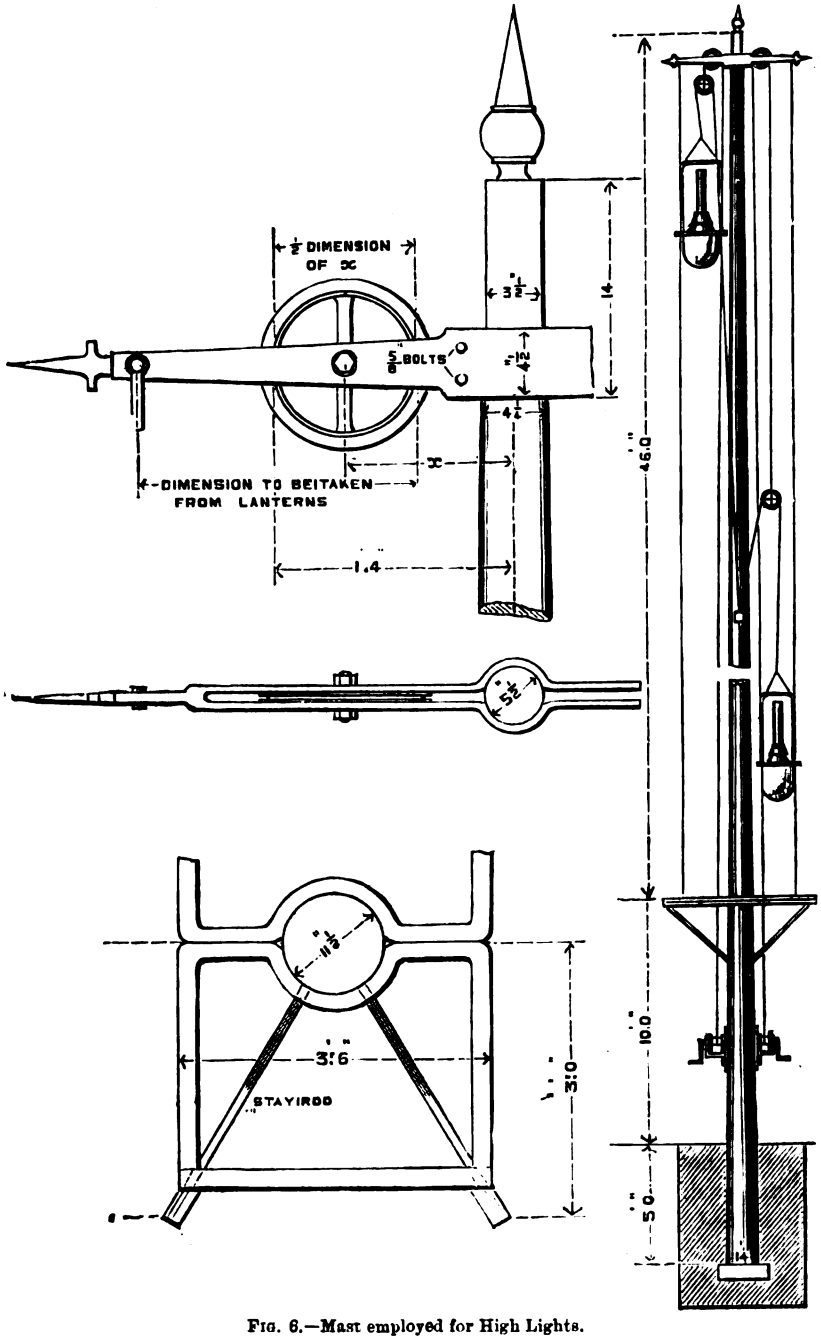

Fig. 6.—Mast employed for High Lights.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was very pleased to find in last week's *Electrician* a reply to your article on the above subject. I should have replied myself, only I felt sure some one better known and more able to discuss the subject would take up the cudgels.

I have for five years used electricity as a curative agent—with success—in cases of paralysis, dipsomania, neuralgia, and many other complaints, also for the extraction of lead and mercury.

I quite agree with Drs. Stone and Kilner that the magnetic belts are valueless.—Yours, &c.,

Archibald Reynalda.

TELEGRAPHS IN RURAL DISTRICTS.

Mr. Fawcett stated in the House on Monday last, "with regard to future telegraph extension under guarantee that by an arrangement lately sanctioned by the Treasury the amount of the guarantee need not be lodged in advance with the Post Office, but guarantors will merely be called upon at the end of each year to make up the deficiency of revenue, if any. This, I think, will be found to be a substantial concession. On the other hand, the Treasury have somewhat altered the principle upon which the amount of the guarantee is to be calculated; and the effect of this will, in some cases, be that the amount will be slightly larger than it would have been under the old system."

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, *Strand, London, W.C.*

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.

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THE ELECTRIC LIGHT AND THE PROVINCES.

When a man has wares to sell his first care is to get them inspected; and when he has induced a possible customer to look at them—there is no harm in just looking—he knows that business is not far off. The vendors of electric lights may take encouragement from this familiar rule of retail trading. Their goods are being shown, and people have come to see them in large numbers. Among the possible purchasers who have helped to swell the crowd which nightly visits the Crystal Palace Exhibition are deputations from a great number of provincial towns. They variously represent the interests of Gas Companies, of Town Councils, or Municipal Governments, who are, or may be, affected by the competition of the electric light, or by local demands for its introduction. They have come, they have seen, and have yielded. At all events they have not conquered the temptation to formally inspect what, if they had no thought of buying, or had made up their minds not to buy, it would have been wiser to have left uninspected. Exhibitors have thus gained a point, and having gained it they may hopefully reckon on trade to follow.

We say this, notwithstanding the unfavourable reports which several of these deputations have already submitted. In some instances it was a foregone conclusion that the reports would be adverse; in others the inferences and conclusions are so utterly mistaken that their "want of reliability"—to use a phrase applied to the electric lights in one of these reports—must very speedily be demonstrated even to the local magnates themselves. When the supply of gas is in the hands of a town council, that is to say when the gasworks are owned and worked by the ratepayers, the introduction of electric lighting is a question mainly of immediate cost; and a decision on this point will depend partly on local circumstances, partly on judicious calculations in respect to ultimate saving. Where the ratepayers are served by a gas company the report varies according to the quarter from which it emanates. If from the representative of the ratepayers, there is a good deal said about the cost of gas, and the possibility—hinted, though, perhaps, not asserted outright—that a little competition might bring down the price of that indispensable, but expensive luxury. If, on the other hand, the report is made by a gas engineer, he is eloquent as to the stability of the gas interests, the inferiority of their electric rival, and, lastly, as to the splendid illumination obtained from some newly-invented gas burner.

It is scarcely necessary to add that the figures in all these reports are, to say the least, highly misleading; and, perhaps, too, the same may be said of "newly-invented gas burners." The public have only one kind of experience in the matter of new inventions patronised by gas corporations—namely, inventions which compel the public to pay for more gas—or air—whether they consume it or not; and as these ingenious but mysterious devices generally come into play whenever there is a nominal decrease in the price of the commodity, the public have grown rather to mistrust all "new inventions" in that particular quarter. These economical burners must be in the same category as the economical gas which, according to one of the reports to which we are referring, is "three times cheaper" than electricity. Rhetoric of this sort can pass muster only in board rooms; and even boards may be credited with eyes, though the possession of souls and bodies has often been denied them.

On the whole these local notabilities appear to have had a pleasant time of it in London; and we cannot complain of the criticism they have met with on their return, for that will compel them to assume an attitude purely defensive. Either they wasted their time and the ratepayers' money—"sundry disbursements" to wit—on the occasion of their visit to the Crystal Palace, or they did not. We, for our part, are persuaded that their visit will not be wasted, and we are sure they themselves will not own that it was. This being the case, we are inclined to regard these intelligent and enterprising travellers as so many prophets, who will return to their own country only to bless what they were commanded to curse. Such, indeed, was the invariable outcome of similar, though, of course, less numerous commissions to the Exhibition at Paris. Then, as now, we were told that the arc light was unsteady, that the incandescent light was costly, and that both alike were liable to instant extinction. It was the duty of the commissioner not to neglect to report upon the defects of the new system; and as to its merits, like the deputations who have lately inspected the lights at the Crystal Palace, he simply damned them with faint praise. But, all the same, streets have been rendered safe and public buildings wholesome by the adoption of the very system these critics were supposed to have condemned.

And so, probably, it will be in respect to the Sydenham Exhibition. The imperfections, real or imaginary, of the several electric lights will be duly reported—and forgotten; their good qualities will be remembered, and in due time will be welcomed everywhere.

OURSELVES.

The second annual gathering of the proprietors, contributors, and friends of *The Electrician* took place at the Criterion on Friday, the 31st ult., when an excellent dinner was done ample justice to, and an evening spent very enjoyably. Mr. J. Pender, M.P., presided, supported by Sir J. Anderson as vice-chairman. The following gentlemen were present:—Sir James Anderson, Mr. Kenneth Anderson, Mr. W. Worby Beaumont, Mr. C. H. W. Biggs, Mr. R. E. Crompton, Mr. Brockwell Dalton, Professor Dolbear (Boston, Mass., U.S.A.), Mr. Desmond G. FitzGerald, Mr. Floreshine, Mr. Garnet (Cambridge), Mr. Hammer (Edison Electric Light Company), Professor Hughes, Mr. J. Laister, Dr. O. J. Lodge (Liverpool), Mr. J. Munro, Mr. Payton, Mr. John Pender, M.P.; Professor J. Perry, Mr. Perry (Lisbon), Mr. W. H. Preece,

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Mr. Saunders, Mr. Schott, Dr. Shettle, Mr. Willoughby Smith, and Mr. F. C. Webb.

In the course of the evening the chairman expressed in warm terms his satisfaction at the progress *The Electrician* had made in public estimation since last they met, and that the objects the promoters kept in view—namely, the representation of the great cable interests by a journal of their own, and the instruction of the *employés* engaged in cable work, had been so fully realised. Those interests were by no means diminishing; but they were now being largely supplemented by telephonic and electric lighting enterprises, which afforded a wide field for a journal such as this.

Mr. W. H. Preece, in responding to the toast of "Telegraphy," mentioned the fact, of which those present had reason to be proud, that wherever they went the apparatus in use all over the world for telegraphic purposes was the handiwork of the Anglo-Saxon race. Mr. Crompton and Mr. Hammar responded on behalf of electric lighting, the latter as representing Mr. Edison. Professor Dolbear, while acknowledging the toast of "Electricians," disclaimed any title to be called an electrician, although he was deeply interested in the future of electricity, and he especially referred to to it in its physiological aspect, a subject to which attention was now, for the first time in this country, being seriously turned. If electricity was "life," then, he thought a "big thing" could be made of it, the prolongation of man's existence being assuredly a paying business, if only it could be well started. Sir J. Anderson, in a congratulatory speech, conveyed the thanks of those present to all contributors abroad, as well as at home. A hearty vote of thanks to Mr. Pender for presiding brought the gathering to a close.

CRYSTAL PALACE EXHIBITION.

Macdonald's New Holophote Course Indicator.

This is an ingenious application of the electric light as an indicator of a ship's course to other ships in her neighbourhood. It is the invention of Mr. J. H. A. Macdonald, of Edinburgh, who is, perhaps, better known in connection with legal questions than with matters electrical.

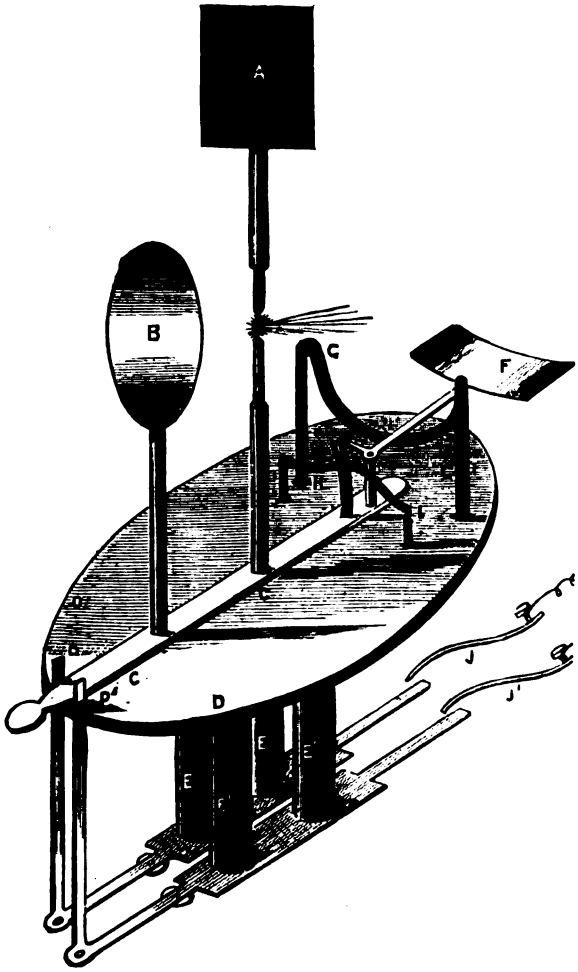

Fig. 1.—Showing Details of the Holophot Course Indicator.

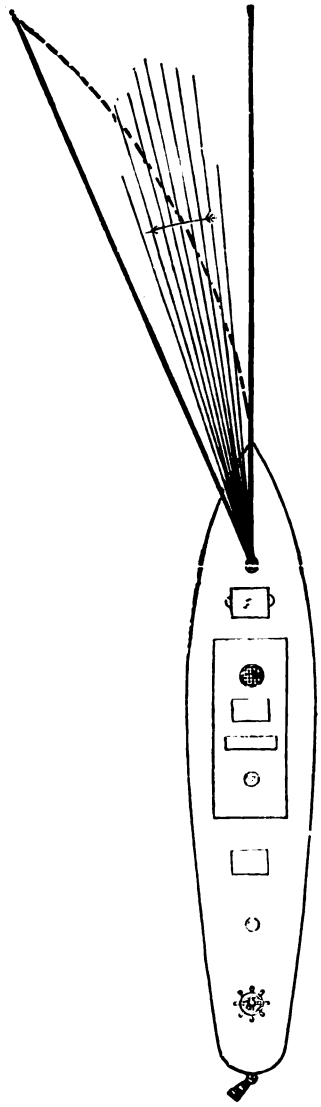

Fig. 2.—Showing the Action of the Course Indicator.

The Holophote Course Indicator consists (Fig. 1) of an electric lamp, A, with a reflector, B, set on a movable handle, C C. This handle is held fast by two detents, D D^1, while the rudder is amidships. When the helm is ported, an electric circuit is established through the electro-magnet E E, by which the detent D is drawn downwards and the handle C C set free to move, so that the reflector B can be swung round, and the light made to wave to starboard. As the handle swings round, the screen F is forced upwards by the curved bar G G, and the pointed inner end of the arm on which the screen F is pivoted pushes back the spring H, and drops into a slot in the top of the spring, which thus holds the screen upright and shuts out the light. The handle is then moved back to its original position, when the spring H being pressed back by the bar I I, the point of the arm carrying

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the screen F is set free, and F falling down exposes the light again. This manœuvre can be repeated in the same way over and over again, as long as the helm remains ported. If the helm be starboarded, the converse movement takes place, exactly in the same manner, the electro-magnet E^1 E^1 drawing down the detent D^1, and the light being made to wave to port. By means of two connecting springs, J J^1, a "tell-tale" is provided, to enable the officer on duty to know if the holophote is being properly worked. When detent D is removed, the handle C C is placed in electric circuit through J with the other detent D^1, so that whenever the handle is swung back to its place, and touches D^1, a bell is rung. *Vice versâ*, when D^1 is removed, the handle C C rings a bell by a circuit through J^1, when it is brought in contact with D. Fig. 2 illustrates the action of the helm on the direction of the light.

This method of causing a ship to indicate the exact course she is holding, and every change in that course, renders it easy for approaching vessels to keep out of her way. At present each is frequently in doubt as to the other's exact course, and just at the last moment a slight change of helm may have been effected without the other vessel having been able to notice it in time to avoid a collision. In addition to indicating the course the electric light is useful as enabling the officer in charge to see further ahead than he would ordinarily be able to do.

Edison's Method of Preparing Carbons.

We illustrate in the accompanying figure (Fig. 1) samples of bamboos brought from South America, Japan, &c., by Mr. Edison's agents, for the purpose of testing them in order to ascertain which afforded the best material for the carbons for his incandescent lamps. Each bamboo was exhaustively tested, till at length a certain one was selected for use. The following are the names of the canes illustrated in the figure:—1, Hauchikee, from Japan; 2, Nebuchitakee, from Japan; 3, Shiho Jikee, from Japan; 4, Sugar Cane, from Venezuela; 5, Horteichikee, from Japan; 6, Kuraichikee, from Japan; 7, Matakee, from Japan; 8, Brazilian, from Para, Brazil; 9, Hauchikee, from Japan; 10, Shikakuakikee, from Japan; 11, Mountain Bamboo, from Japan; 12, Shikakuakikee, from Japan; 13, Brazilian, from Para, Brazil; 14, Shikakuakikee, from Japan; 15, Japanese, from Yokohama, Japan; 16, Torachikee, from Japan; 17, Chinese, from Hong Kong, China.

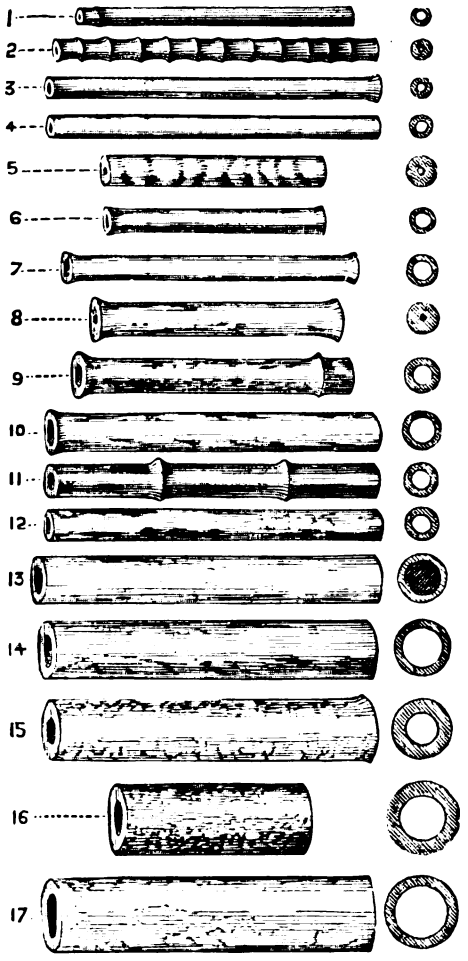

FIG. 1
SAMPLES OF BAMBOO

When a selection had been made, the method of manufacture was carefully considered and every detail arranged, so that the manufactured article should be produced at the lowest cost. Fig. 2 shows the processes of manufacture. The bamboo is taken of proper length 1, and split into two parts 2, 2. Each of these parts is divided into three smaller parts, which are pared down to separate the pithy from the stronger fibrous texture, shown in 3, 4, 5, 6, and 7. When No. 7 stage is arrived at the strip is cut in the shape shown in 8, the thicker ends being so left to obtain good contact, or shaped as in No. 10, when carbons for the smaller lamps are required. Each strip in No. 10 will make two carbons,, as in No. 11. The next stage to Nos. 8 and 11 is the carbonisation of the

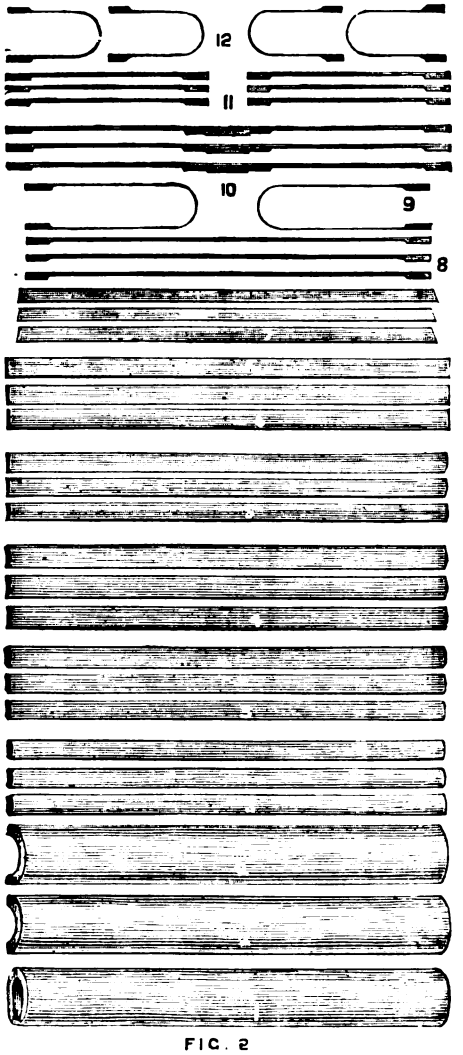

FIG. 2
PROCESSES IN THE MANUFACTURE OF THE CARBONS

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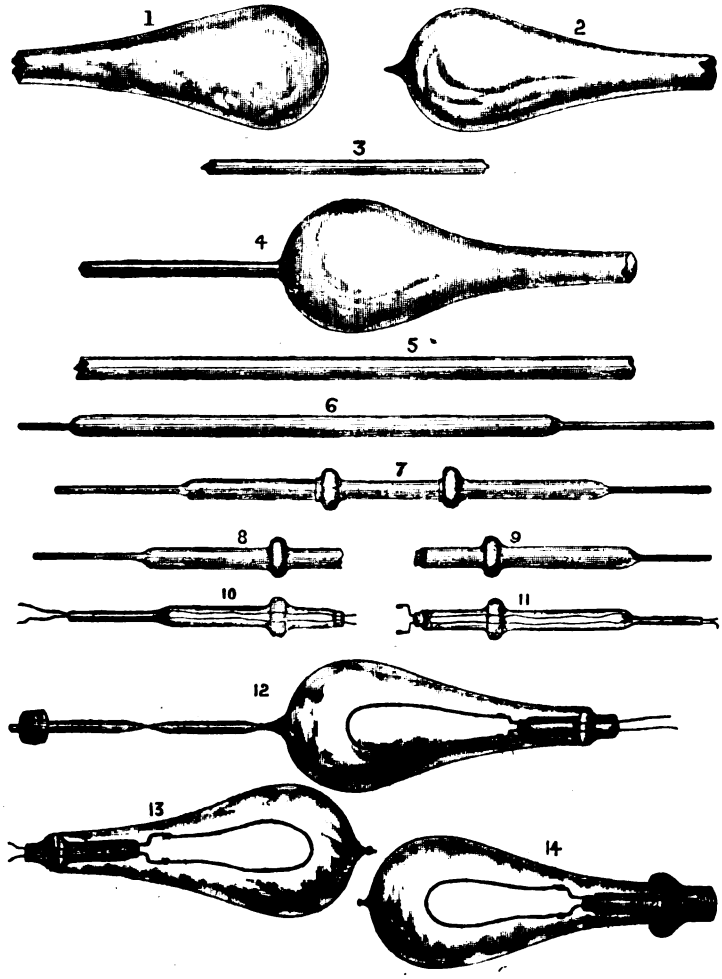
fibre. The process of carbonisation being of a somewhat delicate nature, care has to be taken, or the previous work might easily be spoiled. The filament shaped as in Nos. 9 and 12 is laid in a groove cut in a metal case—the metal generally used is nickel—which groove is covered to render it air-tight, and so prevent combustion. The filament so protected is then placed in the furnace and raised to the temperature required.

In Fig. 3 are shown the various changes undergone by the glass globe from its earliest stage, until it is completed, and the carbon fixed inside. The processes are very simple. The lamp consists primarily of two parts, one the central stem of glass, as shown in Fig. 3, No. 11, into which are fused the conducting wires, to the ends of which the carbon filament is fixed, as in Nos. 12, 13, 14, the other the globe proper, Nos. 1 and 2. The lamp is exhausted from the top, and, when exhausted, sealed, to prevent entrance of air. One conducting wire is in contact with the screw at the lowermost point of the lamp, whilst the other is in electric contact with a brass ring around the rim of what we may call the stem of the lamp. No. 4 shows how the exhausting tube No. 3 is fixed to the globe No. 2, whilst Nos. 5, 6, 7, 8, 9, 10, 11, show the processes gone through in order to form two of the inner stems. Cases containing the above samples are displayed at the Crystal Palace Exhibition amongst Mr. Edison's other exhibits.



PROCESSES IN THE MANUFACTURE OF THE LAMP

Fig. 3.

ELECTRIC DISCHARGE IN A MAGNETIC FIELD.*

BY W. SPOTTISWOODE, ESQ., LL.D., PRES. R.S., M.R.I.

The late Professor Clerk Maxwell, in his work on "Electricity and Magnetism" (Vol. II., p. 146), lays down as a principle that "the mechanical force which urges a conductor carrying a current across the lines of magnetic force acts, not on the electric current, but on the conductor which carries it. If the conductor be a rotating disc or a fluid it will move in obedience to this force, and this motion may or may not be accompanied with a change of position of the electric current which it carries. But if the current itself be free to choose any path through a fixed solid conductor or a network of wires, then, when a constant magnetic force is made to act on the system, the path of the current through the conductors is not permanently altered; but, after certain transient phenomena, called induction currents, have subsided, the distribution of the current will be found to be the same as if no magnetic force were in action. The only force which acts on electric currents is electromotive force, which must be distinguished from the mechanical force which is the subject of this chapter."

In the investigation on electric discharges, on which Mr. Moulton and myself have been long engaged, we have met with some phenomena of which the principle above enunciated affords the best explanation. But whether they be regarded as facts arising out of that investigation, or as experimental illustrations of a principle laid down by so great a master of the subject as Professor Clerk Maxwell, I have ventured to hope that they may possess sufficient interest to form the subject of my present discourse.

The experiments to which I refer, and of which I now propose to offer a summary, depend largely upon a special method of exciting an induction coil. This method was described in two papers, published in the *Philosophical Magazine* (November, 1879) and in the *Proceedings of the Royal Society* (Vol. XXX., p. 173) respectively; but as its use appears to be still mainly confined to my own laboratory, I will, with your permission, devote a short time to a description of it, and to an exhibition of its general effects.

The method consists in connecting the primary circuit directly

* Abstract of a paper read at the Royal Institution on Friday, March 31, 1882.

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with a dynamo or magneto-machine giving alternate currents. In the present case I use one of M. de Meritens's excellent machines driven by an Otto gas engine. The speed of the De Meritens' machine, so driven, is about 1,100 revolutions per minute.

In this arrangement the currents in the secondary are, of course, alternately in one direction and in the other, and equal in strength; so that the discharge appears to the eye, during the working of the machine, to be the same at both terminals.

The currents in the primary are also alternately in one direction and in the other, and consequently, at each alternation, their value passes through zero. But they differ from those delivered in the primary coil with a direct current and contact breaker in an important particular, namely, that while the latter, at breaking, fall suddenly from their full strength to zero, and then recommence with equal suddenness, the former undergo a gradual, although very rapid, change from a maximum in one direction through zero to a maximum in the opposite direction. The ordinary currents with a contact breaker would be represented by a figure of this kind, while those from the alternate machine approximately by a curve of the following form. (Fig. 1) The rise and fall of the latter are, however, sufficiently rapid to induce currents of high tension and of great quantity in the secondary.

From these considerations it follows: first, that as the machine effects its own variations in the primary current, no contact breaker is necessary; secondly, that as there is no sudden rupture of current there is no tendency in the extra current to produce a spark or any of the inconveniences due to an abrupt opening of the circuit, and consequently that the condenser may be dispensed with; thirdly, that the variations in the primary, and consequently the strength and period of delivery of the secondary currents, is perfectly regular; fourthly, that the strength of the currents in the secondary is very great. With a 26-in. coil by Apps I have obtained a spark about 7in. in length, of the full thickness of an ordinary cedar pencil. But for a spark of thickness comparable at least with this, and of 2in. in length, an ordinary 4-in. coil is sufficient.

Owing to the double currents, the appearance of the discharge is that of a bright point at each terminal, and a tongue of the yellow flame, such as is usually seen with thick sparks from a large coil issuing from each. This torrent of flame (which, owing to the rapidity with which the currents are delivered by the machine, is apparently continuous) may be maintained for any length of time. The sparks resemble those given by my great coil (exhibited in this theatre on Friday, April 13th, 1877, and described in the *Philosophical Magazine*, 1877, Vol. III., p. 30) with large battery-power and with a mercury break; but with that instrument it is doubtful whether such thick sparks could be produced at short intervals, or in a rapid shower, as in this case.

In order to contrast the effects of the two methods, I will excite the coil, first with a battery, and secondly with the alternating machine. You will notice that with the battery we can obtain either long, bright, and thin sparks, or short and comparatively thick discharges; but, unless the latter are made very short, they occur only at comparatively long and even perceptible intervals of time. On the other hand, with the alternate machine, although the method does not lend itself so readily to the production of long and bright sparks, we can produce a perfect torrent of discharges more rapid and more voluminous than by any other means yet devised. Long bright sparks can, however, be obtained by interrupting the flow of the currents from the machine, and by allowing only single currents to pass at comparatively long intervals. It may be interesting to know that the number of currents given out by the machine, and consequently the number of discharges issuing from the coil, is no less than 32,000, that is, 16,000 in each direction, per minute. The number may be determined by the pitch of the note which always accompanies the action of an alternate machine.

A comparison of the two methods may also be made when a Leyden jar is used as a secondary condenser. This application of the jar is well known as a valuable aid in spectroscopic research; and the employment of the alternating machine so materially heightens the effects that, judging from some experiments made in the presence of Mr. Lockyer, and from others of a different character in the presence of Professor Dewar, I am led to hope from it a further extension of our knowledge in this direction. In order that you may form, at all events, some rough idea of the nature of such discharges, I venture, at the risk of causing some temporary inconvenience from the noise, to project the spectrum of this spark.

I will detain you with only one more instance of comparison. The ordinary effect of an induction coil in illuminating vacuum tubes is well known. The result is usually rather unsteady. Several instruments have been devised to obviate this inconvenience, *e.g.* the rapid breakers described in the *Proceedings of the Royal Society* (Vol. XXIII., p. 455, and Vol. XXV., p. 547), or the break called the "Trembleur" of Marcel Deprez (*Comptes Rendus*, 1881, I. Semestre, p. 1,283). The use of the alternating machine, however, not only gives all the regularity in period, and uniformity in current, aimed at in these instruments, but also at the same time supplies currents of great strength. The result is a discharge of great brilliancy and steadiness, and it is, perhaps, not too much to say that the effects are comparable to those obtained with Mr. De La Rue's great chloride of silver battery. The configuration of the discharge produced in this way can also be controlled by a suitable shunt applied to the secondary circuit; for example, one formed by a column of glycerine and water, or the one consisting of a film of plumbago spread upon a slab of slate, constructed by my assistant, Mr. P. Ward, and here exhibited.

One test of the strength of current passing through a tube is the amount of surface of negative terminal which it will illuminate with a bright glow. I here have a tube with terminals in the form of rings, each of which would be regarded of ample size for currents obtained in the ordinary way. These are now all connected together so as to form one grand negative terminal; and it will be found that with the currents from the alternate machine the whole system is readily illuminated at once.

It should, perhaps, be here remarked that, while the strength of the secondary currents passing through the tube is partly due directly to the strength of the primary currents from the machine, it is probably also in part due to the rapidity with which the secondary currents follow one another. Owing to the latter circumstance the column of gas maintains a warmer and more conductive condition than would prevail if the interval between the discharges were longer; and in consequence of this a larger portion of the discharges can make its way through than would otherwise be the case.

Before leaving the instrumental part of my discourse, I desire to bring under your notice a modification of the machine which we have thus far used for producing, by the intervention of the induction coil, currents of high tension. This consists of a machine of the same general construction as the other, but having the armatures wound with a much greater number of convolutions of much finer wire. The result is a machine giving off currents of sufficient tension to effect, by direct action, discharges through vacuum tubes, and even in air. The currents are, of course, alternate; but by diminishing the size of one of the terminals to a mere point, as well as by other methods described elsewhere, it is possible to shut off the currents in one direction, leaving only those in the other direction to discharge themselves through the tube. I hope on some future occasion to give a fuller account of this remarkable machine, which has only quite recently been completed.

Returning to the discharge in air, it will be noticed that when the terminals are set horizontally the torrent of thick discharges assumes the appearance of a flame, which takes the form of an inverted V. This is the result of convection currents due to the heat given off by the discharges themselves. The discharges are by their nature as it were fixed at each end, but within the limits of discharging distance free to move about and to extend themselves in space, especially in their central part. Further, it may be observed that the length of the spark which can be maintained is greater than that over which it will leap in the first instance. The explanation of this is to be sought in the fact that when the sparks follow very rapidly in succession, the whole path of each discharge remains so far in a heated state as to assist the passage of the next; and, further, that in the middle part of the discharge or apex of the Λ, where the heat is greatest, the heat prevails to such an extent as to render a portion of the path highly conductive. This may be illustrated by holding a gas jet near the path of the discharge. The flames will then leap to the two ends of the jet, which will perform the part of a conductor; and the real length of the discharge will be that traversed from terminal to terminal, minus the length of the intervening flame. The permanently heated part of the flame will act in the same manner in extending the effective length of the discharge.

The discharge which we are now examining is not homogeneous throughout, but consists of more than one layer. The flame, which, from the fact of its forming the outer sheath of the discharge, is the most prominent feature, consists mainly of heated, but solid, particles emanating from the terminals. That this is the case may be inferred in a general way from the colours which the flame assumes when different substances are placed upon the terminals; for example, lithium or sodium. The spectrum of the flame appears to be always continuous. A convenient substance to affix to the terminals is boron glass, on account of the brilliancy to which it gives rise in the discharge; this will enable us to project the phenomenon. Within this sheath of flame, the discharge consists of the pink light characteristic of air, and in the centre of all the true bright spark. There

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is reason to think that, under certain circumstances, there are more layers to be seen; but the above division is sufficient for our present purpose. In this somewhat complicated structure, the pink light corresponds to the arc, and the flame to a similar accompaniment which is seen playing about the upper carbon in electric lamps when a current of great strength is used.

From this account of the methods here employed I now turn to the main question. In the investigation, to which allusion was made at the beginning of this lecture, it occurred to us that an examination of the effects of a magnetic field on discharges of this character through air or other gases at atmospheric pressure, and a comparison with those obtained at lower pressures, might throw some fresh light on the nature of electrical discharges in general. It is these phenomena to which I now propose to ask your attention.

When the discharge, originally in the form of a vertical spindle, is submitted to the action of a magnet whose poles are horizontal, it spreads out into two nearly semi-circular discs, one due to the discharges in one direction, and the other to those in the opposite direction. As the magnetism is strengthened, the flame retreats towards the edge of the discs, and ultimately disappears. The disc then consists mainly of the pink discharge; but with a still stronger magnetic field, it is traversed at intervals by bright semicircular sparks at various distances from the centre. In every case, bright sparks pass directly

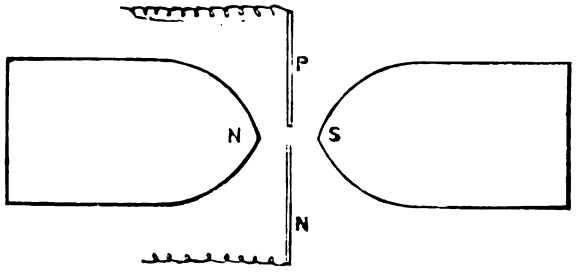

Fig. 2.

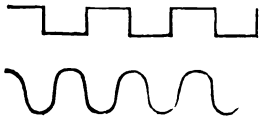
Fig. 1.

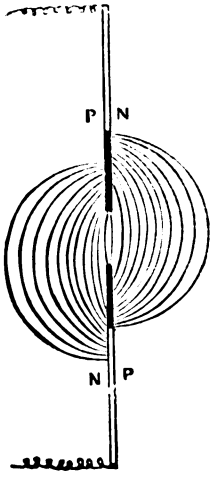

Fig. 3

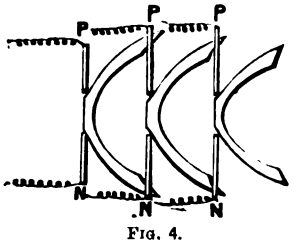

Fig. 4.

between the terminals at the opening of each separate discharge.

In order further to disentangle the parts of this phenomenon, recourse was had in the original experiments to a revolving mirror. The light in the discs is insufficient to allow of a projection of the effects, but the accompanying diagrams represent the appearances seen in the mirror. Fig. 2 shows the arrangement of the terminals and the magnetic poles; Fig. 3 the appearance of the discharges in a plane at right angles to that of Fig. 2; Fig. 4 the appearance of three successive discharges (in the same direction) with a weak magnetic field and a slowly revolving mirror; Fig. 5 the same, with a slightly more rapid rate of revolution; Fig. 6 a single discharge, with a stronger field and greater speed of mirror; Fig. 7 a single discharge in a strong field, with a still greater speed of mirror. It should be mentioned that in all these figures the images to the left are to be regarded as anterior to those on the right, and that they represent various phases of the left-hand discharge in Fig. 3.

If, however, we observe the right hand discharges with a mirror revolving in the same direction as before, it is clear that the actual curvature of the discharge will be turned in the opposite direction (with reference to the motion of the mirror) to that in the case of the left-hand discharges. The consequence will be that the appearance in the mirror, when the rate of revolution is not too great, will be something like Fig. 8, instead of Fig. 7. As the speed of the mirror is increased, the convexity will diminish, and ultimately be replaced by a concavity of the same kind, although not so marked, as that in the case of the left-hand discharges.

These diagrams show that each coil discharge commences with a bright spark passing directly between the terminals; that this spark is in general followed by the pink light or arc discharge, which passes first in the immediate neighbourhood of the initial spark, and gradually extends like an elastic string in semi-circular loops outwards; and that the flame proper is a phenomenon attendant on the close of the entire discharge. It should be added that observations with a mirror revolving on a horizontal axis, and with a horizontal slit in front of the discharge, show that the disc is not simultaneously illuminated throughout, but that it is a locus of a curvilinear discharge which moves outwards and expands in its dimensions from the centre.

The mechanism of the discharge would therefore seem to be as follows:—In the first place, as soon as the tension is sufficient, the electricity from the terminals breaks through the intervening air, but with such rapidity that the fracture is like that of glass, or other rigid substance. This opens a path, along which, if there remains sufficient electricity of sufficient tension, the discharge will continue to flow. During such continuance the gas becomes heated, and behaves like a conductor carrying a current; and upon this the magnet can act according to known laws. As long as the electricity continues to flow, the

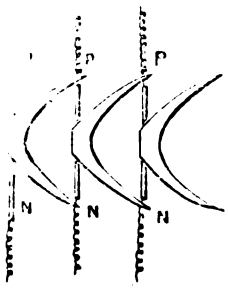

Fig. 5.

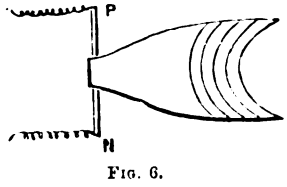

Fig. 6.

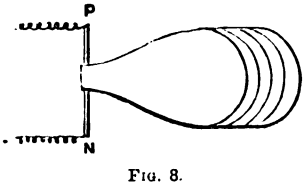

Fig. 8.

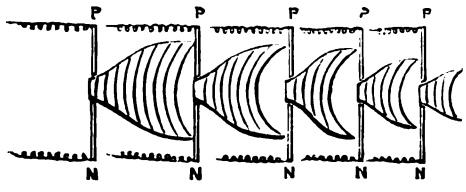

Fig. 7.

heat will at each moment determine the easiest, although not the shortest path for its subsequent passage. In this way the gas, which acts at one moment as the conductor of the discharge, and at the next as the path for it, will be carried further and further out until the supply of the electricity from the coil fails, and the whole discharge ceases. We are, in fact, led by these experiments to the conclusion that it is the gas in the act of carrying the current, and not the current moving freely in the gaseous space, upon which the magnet acts.

This explanation of the magnetic displacement of a discharge receives strong support from the phenomena represented in Figs. 6, 7, and 8. The successive bright lines there shown must be due to successive falls and revivals of tension within a single coil discharge. The existence of such alternations in coil discharges of large quantity is otherwise known. When the fall in temperature is such that the conductivity of the gas is insufficient to maintain the arc, the discharge can make its way through the air only by a fresh rent of the same kind as the first fracture. But how can this be reconciled with the fact that the tension can never reach its original degree, and must, on the whole, be gradually falling, and that, in addition, the paths represented by these various sparks are successively longer and longer? The answer to this question is to be found plainly written in the phenomena themselves. Any irregularity in one of these bright lines is always found to be accurately repeated in all of the same series. Now, it is scarcely to be conceived that, at successive instants of time and in different portions of space, irregularities in the discharge itself, and in the distribution of the gas, so precisely the same, would constantly and for certain recur; and we are therefore driven to the conclusion that it is the same portion of gas

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which at first occupied the centre of the field, with its same yet unhealed rent, which is moved outward under the action of the magnet. If this be so, we have in this repetition of minute details nothing more than what would necessarily follow from successive reopenings of the weak parts of the gas, which would be surely found out by the electricity in its struggle to pass.

The view here taken of the material character of the luminous discharge is further borne out by the fact that the spindle of light is capable of being diverted by a blast of air. When the blast is gentle, the discharge becomes curvilinear, approximately semicircular, and the yellow flame may be seen playing about the outer edge, in the same way as in a weak magnetic field. When the blast is stronger, the sheet of light becomes irregular in form, and it is traversed by a series of bright lines, all of which follow, even in their minute details, the configuration of the sheet. The analogy between this and the phenomena produced in a strong magnetic field needs no further remark. If the strength of the blast be still further increased, the flame and the sheet of light both disappear, and nothing remains but bright sparks passing directly, and undisturbed, between the terminals. In this case the air is both displaced and cooled so rapidly by the blast, that it no longer offers a practicable conductive path for the remainder of the electricity, coming from the coil, to follow. Of this a succession of disruptive sparks is a necessary consequence.

The effect thus produced by a very strong blast is in fact similar to that observed when a jar is used as a secondary condenser. In this case the electricity, instead of flowing gradually from the coil, passes in one or more instantaneous discharges with finite intervals of time between them. Each of these has to break its way through the air; and, that done, it ceases. Hence, neither a magnet, nor a blast of air will have any effect in diverting such a discharge.

As a last stage of the phenomena, it may be mentioned that, if the interval between the terminals be near the limit of striking distance, either a blast of air, or the setting up of a magnetic field will alike extinguish the discharge.

Our experiments have been thus far carried on in air at atmospheric pressure; but there is nothing in this pressure which is essential to them or to the conclusions to which we have been led. We may therefore repeat them in air, or any other gaseous medium, at any pressure we please. This consideration leads us into the region (so fertile in an experimental point of view) of discharges in vacuum tubes.

Commencing with a tube of moderate diameter and of very slight exhaustion, we can at once recognise our former phenomena slightly changed. Proceeding to another tube, of larger diameter and of moderate exhaustion, and placing it axially or equatorially in a magnetic field, we see not only that the discharge (or rather the conductor carrying it) is displaced, but also that the displaced part is spread out into a sheet or ribbon, showing that the discharge is affected gradually, exactly in the same way as was found in the open air.

When the exhaustion is carried further, the phenomena become rather more complicated. At an early stage there is a distinct separation between the "negative glow" and the rest of the luminous column; and at a more advanced stage the column itself is broken into separate luminosities or striæ. When this is the case, it is usually said that the negative glow follows the lines of magnetic force, while the luminous column distributes itself according to Ampère's law.

It will be my endeavour to show that when completely analysed, the action of the magnet upon the striæ, taken individually, is the same as that upon the negative glow, due allowance being made for the differences in local circumstances subsisting between the one and the other. We have elsewhere shown that the negative glow is in reality as truly a stria as any other individual member of the luminous column; but with this difference, that it is anchored to, and dependent for its form on, a rigid metallic terminal, whereas each of the others is dependent on the variable form and position of the stria immediately next in order, reckoning from the negative end of the tube. The action of a magnet in throwing the negative glow into a sheet of light, which is the locus of the lines of force passing through the terminal, and which consequently varies with the position of the tube in the field, is a phenomenon so well known that we need repeat only a single experiment by way of reminder.

Although it is not altogether so easy to show that the other striæ are directly affected by a magnetic field in the same way as is the anchored stria, we may still satisfy ourselves that it is the fact, from the consideration that when the striæ are well developed and the magnetic field is strong, it is quite possible to form a magnetic arch at any part of the column. In this experiment it will be noticed that for the formation of the arch in mid-column it is necessary that both poles of the magnet should act upon one and the same stria. This, in fact, means that the pole nearest the negative end anchors the stria, and thereby brings it into conditions similar to those of the negative glow. When this is effected the two exhibit similar modifications in the magnetic field.

In support of this view, we may adduce another and quite independent method of anchoring a stria, and of thereby producing a magnetic arch elsewhere than at the negative terminal. It was noticed by Goldstein and others that if the negative terminal of a tube be enveloped by an insulating surface of any form pierced with a number of holes, or if a diaphragm similarly pierced be placed anywhere in the tube, that the pierced surface will act as a negative terminal. He also found that the finer and closer the holes, the more complete the resemblance to the action of a negative terminal. But even when the substance is metallic, and when the holes are neither very small nor very numerous, a perforated diaphragm will so far act like a negative terminal as to serve as a point of departure of a stria. There is, however, this difference, that the blank space immediately adjoining the diaphragm, as it is usually called, is not generally so large as that at the true terminal; and the striæ thus artificially formed always lie close up to the holes. The diaphragm, in fact, anchors the stria, and renders it susceptible of the same magnetic effect as was shown in the cases studied before.

The action of a diaphragm in a magnetic field gives rise to many other interesting and remarkable results; some of which would further illustrate the views now submitted for your consideration. But these must be reserved for another occasion.

In the foregoing experiments, and in the remarks which have accompanied them, I hope to have established that in the displacement of the discharge in a magnetic field, the subject of the magnetic action is the material substance or medium which conveys the current; that, even when the discharge takes place in media so attenuated as to produce the phenomena of striæ, the same is true not only as regards the discharge as a whole, but also in each component stria or unit; and that the apparent diversity of effect on the various striæ is due to local circumstances, and not to any fundamental difference between the "negative glow" and the members of the "positive column."

Seeing now that the magnetic displacement of the luminous discharge means displacement of the matter in a luminous condition, and that a crowding of such luminous matter involves an increase of luminosity, may we not infer with a high degree of probability that the striæ are themselves aggregations of matter with dark and comparatively vacuous spaces between them? Such a view of the case would seem to imply that, in gaseous media, the better the vacuum the more easily can the electricity pass.

This might at first sight appear to be at variance with the known fact that the resistance of a tube decreases with the pressure until a minimum, determinate for each kind of gas, and then increases. But it has been suggested by Edlund ("Annales de Chemie et de Physique," 1881, tom. iii. p. 199) that the resistance of a tube may really consist of two parts, first that due to the passage of the electricity through the gas itself and, secondly, that due to its passage from the terminals to the gas; and also that the former decreases, while the latter increases, as the pressure is lowered. On this supposition the observed phenomena may be explained, without assigning any limit to the facility with which electricity may traverse the most vacuous space.

We may even carry the suggestion of a resistance of the second kind a little further, and suppose that there is a resistance due to the passage of electricity from a medium of one density to that of another, or from layer to layer of different degrees of pressure. And from this point of view we may regard the striæ as expressions of resistance due to the varying pressure in different parts of the tube. Into the question, whence this variation of pressure, I am not at present prepared to enter; it must suffice for this evening to have shown that the conclusions which we have drawn from our experiments are not in disaccordance with other known phenomena of the electrical discharge.

THE SELLON AND VOLCKMAR SECONDARY BATTERY.

A private exhibition of this battery was given on Tuesday evening at the Crystal Palace by the Electrical Power Storage Company, which has been recently formed to acquire and work the patents of Messrs. Sellon and Volckmar relating to secondary batteries. The capital of the company is £800,000, all of which has been privately subscribed. Prior to the inspection of the batteries at work the gentlemen who had been invited for the occasion were entertained at dinner in the Palace by the company. Amongst the guests were:—Mr. Warren de la Rue, Professor Crookes, Admiral Englefield, Professor Hughes, Sir G. Matthews, Dr. Hopkinson, Professor Dewar, Dr. Huggins, Mr. Alexander Siemens, Mr. Latimer Clark, Mr. Crompton, Mr. St. George Lane-Fox, Professor Silvanus Thompson, Professor Adams, Mr. Fletcher Moulton, and other well-known electricians and men of science. Letters, regretting their inability to attend, had also been received from the Earl of Crawford, Mr. Spottiswoode, Sir

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Cunliffe Owen, and Dr. Siemens. Sir Daniel Cooper, chairman of the company, presided.

At the close of the dinner the CHAIRMAN gave the usual loyal toasts, followed by that of the "Crystal Palace Company, coupled with the name of Mr. M'George," one of the directors, at the same time alluding to the magnificent display of electric lighting and electrical appliances in general that had been brought about by the company's agency.

Mr. M'GEORGE briefly acknowledged the compliment that been paid to him, and alluded in humorous terms to the large 150,000 candle Brush light, which he said he should like to see outside the building, where its capacities could better be tested, and he hoped Mr. Sellon would see his way to effecting this change. He concluded by proposing the toast of "The Electrical Power Storage Company," coupled with the names of Sir Daniel Cooper, Mr. Sellon, and Mr. Volckmar.

Sir D. COOPER having expressed his conviction as to the great future in store for the company's manufactures,

Mr. SELLON, vice-chairman of the company, and one of the inventors of the battery, was called upon, and said: I naturally hesitate to make any statement which may appear in great part to concern myself, but I feel that it is due to those who have by honouring us with their presence to-night, very clearly shown that they take interest in the subject that is before us, that I should give them certain facts in connection therewith, describing the history of what have been called the "Sellon and Volckmar Accumulators," and furnishing such data as I am able of their capabilities. In dealing with this subject I am most reluctantly compelled to travel beyond the range to which I should otherwise have limited myself. I must say a few words with regard to another system of electrical storage in secondary batteries, which has been long prominently before the public in print, and to which I would rather not have referred, but this course has been forced upon me by the appearance in one of the daily papers, within the last few days, of an advertisement, the audacity of which has, perhaps, never been equalled. It professes to emanate from the president of the "Faure Accumulator Company," in Paris, and I would fain believe that the administration of the English company, recently launched in London, have not sanctioned, if they have not tried to prevent, its publication.

I will read you this extraordinary production, and then, with your permission, will comment upon it paragraph by paragraph. I can only wish, for reasons which will be obvious, that it had been published in a much wider sphere than the circulation of a single newspaper, for it contains admissions which, in my opinion, must prove entirely fatal to the success of the Faure accumulator, under the admitted system of manufacture, and shows how far behind recent progress the scientists of that company must still be. The advertisement is as under:—

THE FAURE ACCUMULATOR.—NOTICE. For some time past the advent has been pompously announced of a new Secondary Battery, said to be infinitely superior in capacity and durability to that of Faure.

The construction of this Battery is perfectly well known to the undersigned, although it has not yet been shown out of the laboratory where it was made; it is neither better nor worse than a Faure Battery, inasmuch as it is a Faure Battery, made by discharged employés and workman from the Faure factory, in Paris.

It is composed of perforated or corrugated plates of lead, on which are encrusted or intercalated oxydes of lead, minium of letharge, lead dross, or finely divided or reduced lead. The professed inventor of this Battery (whose plagiarism will be proved at the proper time) naïvely imagines that by this process, which has been long ago described and employed, he can do without asbestos, felt, or other substances destined to serve as supports to retain the reduced lead and peroxide in their places, and even goes so far as to minutely describe in his patent the details copied from the patent accorded to Mr. Faure.

Finally, whether made with or without supports, these batteries cannot be made in Great Britain or elsewhere without proper license and permission from the owners of the Faure Patents.

THE PRESIDENT OF THE SOCIETE ANONYME
LA FORCE ET LA LUMIERE.

March 24, 1882.

Now, gentlemen, if these statements were true, I should indeed be unworthy of addressing you to-night. It would be an insult to you to have asked you to come and see our exhibit, and it would be an insult to the Crystal Palace Company to have taken up their space with an imposture of so glaring a character.

1st. As to pompous announcements of the new secondary battery—beyond a very small circle of friends no mention has ever been made of what has been achieved—no public announcements or notices of any kind have ever been put forward, even the small company (I say small as to numbers) which has been formed with a capital of £800,000 for the exploitation of these secondary batteries throughout the world, was formed, and the whole of the capital subscribed amongst my own circle of private friends within a few hours, and would have been subscribed three or even ten times over. There has been no occasion for pomposity or announcement, and possibly no undertaking has ever been launched with so few words. Not one of the general public has been asked to subscribe for a single share; in fact, my great difficulty has been in cutting down my friends' demands. This accusation of pomposity must make you all smile when you look back to the startling and sensational tactics about a year since of those interested in the Faure battery. The marvellous letters and articles which appeared in one or more of the leading papers, the placarding throughout Paris of what the "Société de la Force et la Lumière" would be able to effect by October last, how every householder throughout Paris who then chose to subscribe would have supplies of electricity at his own door every morning, how throughout Europe and America it was advertised, written about and extolled. And with what result? I ask do any of you know of one single working or workable installation of the Faure battery in any part of the world at the present time. Have any of you been able (and I know many have endeavoured) to purchase and thereby secure private possession of one single set of cells? Have any cells been submitted to the test of time in the hands of disinterested persons? The only opportunity which within my knowledge has been afforded to a section of the public to form any partial judgment of the working of these cells was at the Paris Exhibition. There, under the management of a large staff, with the best facilities for work, and under the most favourable conditions to ensure any possible success, a certain number of cells were shown at work for a few months, and with what results as to power consumed, regularity in working, and wear and tear, I leave to the judgment of those who enjoyed the opportunity of observing them.

Secondly comes the statement that the combination of the new battery was known to the president of the company whilst in course of construction in my private laboratory—that it is neither better nor worse than a Faure battery—that it is in fact one made by discharged *employés* of the Faure company.

Gentlemen, the first part of this statement would tend to confirm an anonymous communication I received, and to which I paid no attention, that a detective has been employed who has bribed one or more of my workmen to give a daily report of what is being done at my private laboratory.

The question of comparative quality and identity of the new battery with the "Faure" will readily be arrived at by the scientists who will shortly, I trust, take the matter in hand.

The statement that discharged workmen of the Faure company have been employed by me is absolutely untrue. I have never employed, spoken to, nor within my knowledge have I ever seen such men.

3rd.—This paragraph is so far true that perforated or corrugated plates *are used*, and in these forms lies one of the points covered by the patents possessed by the "Electrical Power Storage Company;" patents as regards one of them, taken out as early as May in last year, before any Faure patent was published. I would venture the query to the Faure Company, Have you not now, since the publication of these patents, made use of perforated plates, in order to secure the better adhesion of your oxides, and the more ready working of your batteries? Will you open those cells from which you have lately obtained better results than heretofore, and prove that you have not in this respect already infringed the patents possessed by my company? I should be glad to know that this is not so. Of the material to be rendered active, which is intercalated (to use their expression) in the plate, I choose to say nothing at present; all such details will be known in due time.

As to my "naïve imagination" that wrappings of felt, asbestos, or other material are not required, I fear that the facts accomplished show that this has gone far beyond the imaginative limit. The absence of such packings and wrappings is not only one of the strong points of success in the new battery, but I go so far as to say that it is doubtful whether any form whatever of these batteries which is dependent upon such wrappings can be a permanent success. I look forward to the time when huge plates, say of half a ton or a ton each perhaps, may be impressed into the service of this work, the cells being formed of masonry tanks, and of a size which may supply not hundreds only, but many thousands of lamps from one reservoir. How are such plates to be swaddled up, even supposing that any material that could be used would be proof against the action of acidulated water and gases. It is in my opinion an unpractical form, and the obstinacy which disregards improvements which obviate its inconvenience can have but one result.

4th.—The last paragraph deals with a question which it is a more delicate matter to touch upon—I will only say that by one of the first opinions in England it is held that the patents my company possess are good, valid and substantial in themselves, and without discussing the position of those held by the Faure company I will only say that we are ready at once to join issue with them upon any point they raise, and in making present sales, to indemnify the purchasers against any adverse issue. I state frankly and openly that, if it can be justly proved that our patents are in any one point tributory to the Faure, we would most willingly recognise the fact. I have too great a regard for the rights of inventors not to be the first to protect them, whether or not to my disadvantage; but I maintain that the new batteries are essentially different from the Faure in construction, in effect, in durability, whilst such points as are claimed and patented in them are valid and substantial, and all other points are open to the public.

Nevertheless most willingly would my colleagues and myself have held out the hand of fellowship to our competitors, and have worked honorably side by side without jealousy or dispute, running, of course, the race of competition, which must be entered upon in these progressive days, feeling that, although whatever system best merits the greatest success, it will in the end attain it, yet that there is room enough and to spare for both to be fully engaged in the work which lies before us.

Please understand that I have no wish to detract from or to disparage the work of Mr. Faure. His labours have been the means of directing great attention to the principle of secondary batteries—witness how many minds have been turned in that direction as evidenced by the patent lists—and I fully accord to him the recognition he deserves, but, at the same time, we must not overlook the anterior claims of others too numerous to mention, but amongst whom stand out prominently the names of Schonbeck, De la Rive, Ritter, Becquerel, Planté, Hospitalier, and D'Arsonval.

It may interest you to know that in my library I have a work published as long ago as 1844 in which the use of peroxide of lead either mechanically packed round a metal plate or deposited thereupon and attached to a suitable negative is mentioned as a good arrangement for an electro-motor or for a "depolariser." The fact of its being powerful and active is mentioned, and this statement covers effectually, in my judgment, the principles of secondary batteries so constructed.

The disagreeable portion of what I have had to say is, I hope, completed. I have, I fear, trespassed greatly on your patience. Kindly accept as my excuse that until I had dissipated the various statements contained in the public notice above referred to I could not venture to ask you to show any interest in the principle of the much maligned batteries which I propose to show you at work this evening.

I will now shortly describe to you their history, and say what they will do. I give the history because so much interest has been now aroused in the matter that I would wish to place it on record.

In September last I took out certain patents relating chiefly to the form of plates for secondary batteries, intending to take them out for abroad in an amalgamated form when the time arrived to file my English finals. In the course of events some three or four months later I came in contact with Mr. Volckmar, who, in October, had taken out patents in the same direction. In him I recognised a gentleman of great power of work and of perfection in detail; and I may here explain that the finishing touch of success

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as to the increased efficiency of these batteries is in great part due to him. We ultimately, as you are aware, joined forces, but meanwhile I found that Mr. Joseph Swan, of well merited fame in the electrical world, whose brother we have the pleasure of meeting to-night, had anticipated so far back as May last one of the forms of plates covered by both Mr. Volckmar and myself. I speak of "form of plates" in contradistinction to "formed plates," and Mr. Swan will, I know, allow me to say that he had not, at any rate at that time, worked out to a successful issue the principle of his patent. I immediately communicated with him, gave him my provisional patents to read, and ultimately purchased from him his patent rights over the whole world, so that no question or dispute could arise in the adoption of any forms of plates so covered by patent rights. The Electrical Power Storage Company possess, therefore, the patents of Mr. Volckmar, Mr. Swan, and myself. The batteries themselves I shall have the honour of showing you presently—you must form your own judgment of their practicability and efficiency. I will only state that, of the sizes now made, one standard size of the dimensions of 43-100ths of a cubic foot, and containing of metallic composition about 62lb., will yield when properly charged an aggregate amount of current equivalent to fully one horse-power of electrical energy for one hour, giving off from 350 to 400 amperes at any required rate up to 40 amperes per hour. The next standard size contains of metallic composition rather less than 300lb, and can yield 5 h.-p. of electrical energy for an hour—giving up its 1,800 to 2,000 amperes at any rate up to 200 or 250 if required. One set of 39 such cells will later on be seen working 200 Lane-Fox lamps in the Alhambra Courts. The plates have no supports, and are simply in appearance solid pieces of metal separated by slips of wood, and immersed in acidulated water. In reality they are full of interstices or holes, which contain the packed material. This is applied in such a form that it makes a solid alloy (if I may use the term) with the plates themselves. For the definite determination of the points at issue I take this opportunity of making the following proposition:—

That a written statement shall be made by the Faure Accumulator Company, and by the Electrical Power Storage Company, as to the form and the work that can be done by their respective sets of cells now being exhibited in this building; that a scientific committee be appointed, consisting of at least four well known names in the scientific world, and some representatives of such scientific journals as have more especially taken interest in and furnished the public with information on subjects in connection with electricity. I would suggest that *The Electrician*, *Electrical Review*, *Engineering*, and *The Engineer* should be asked to furnish representatives for this purpose.

That this general committee proceed at once to examine the statements made, and to confirm them in so far as the construction of the cells now exhibited is concerned, and their present condition, and that they shall mark the various sets of cells under seal.

That a record shall be kept of the work respectively done during the continuance of the exhibit at Sydenham, and that at the conclusion of the exhibition the cells shall be examined as to their respective condition, and placed under the control of the examining committee for a certain period for confirmation of the statements made as to their power of work. The professional expenses incidental to this arrangement to be borne equally by both sides. The comparative results, whatever they may be, to be certified and published.

Now as to the practical application of these batteries. To my mind their employment will be almost unlimited. I can conceive no installation of domestic electric lighting to be complete without them, whether as a supplying or as a regulating medium. For motive power I anticipate immense demand; and although the factory now nearly in course of completion is upon a scale somewhat commensurate with the business in hand, yet I feel confident that it will form but the nucleus of an immense and important industry.

The application of the forces of nature, such as wind, running and tidal water power, will now, doubtless, receive more engineering attention than heretofore; and electrical energy, which upon its generation can now be stored and reserved for use as required, must become a much sought for and highly prized source of power. To regard the use of these batteries only as a small matter of personal convenience, take, for instance, my own case. Up to the introduction of these batteries it had been necessary for me to keep one of my gardeners every evening attending to the engine and dynamo-machine up to whatever hour light might be required; for the future he need only set the charging of the batteries in action during the day, and my store will be ready for evening use without fluctuation or intermission. The durability of the incandescent lamps is also greatly increased and the lights can be regulated to any required degree of intensity if you diminish your electromotive force by cutting off so many cells, and you thereby conserve so much of your electrical power.

Mr. Volckmar having been called upon,

Mr. COURTENAY, one of the directors of the company, rose to reply in his stead, explaining that Mr. Volckmar being a foreigner felt diffident in expressing himself in English, though anyone who had conversed with Mr. Volckmar would bear him (Mr. Courtenay) out when he said that he spoke that language remarkably well. He had to state on behalf of Mr. Volckmar that a certain pamphlet which had been circulated on the Stock Exchange and elsewhere in the City during the last twenty-hours, and purporting to be a report of certain proceedings that had been taken by the Faure Company in a French court against Mr. Volckmar, was either a fabrication or a hoax, he could hardly say which, and as no printer's name had been attached to this document there was some difficulty in arriving at its source. He was, however, authorised by Mr. Volckmar to say that he (Mr. Volckmar) had never heard of these proceedings, and denied in toto the whole of what was alleged against him in the report thereof.

A vote of thanks to Sir D. Cooper for presiding having been passed, the guests adjourned to the Alhambra Court, to witness the batteries in action. As the details of the exhibit have already been given in Mr. Sellon's speech, it is unnecessary to allude to them further. The ease with which the lights could be lowered by the switching off of one or more cells was shown, and the many questions of those present courteously replied to by Mr. Sellon and Mr. Volckmar. We may add that the light given by the Lane-Fox lamps, supplied by the Brush company, was beautifully soft and mellow, due in a measure, no doubt, to the carbons being contained in frosted globes, and the general effect was much admired.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

The seventeenth ordinary general meeting of the above company was held at the City Terminus Hotel, on the 31st ult., under the presidency of Mr. Edmund Etlinger, in the absence of the chairman of the company (Mr. Neil Bannatyne), who had been compelled to go abroad.

The MANAGER (Mr. Charles Gerhardi) having read the notice convening the meeting, the report of the directors was taken as read.

The CHAIRMAN: Before moving the adoption of the report, perhaps you would like me to make a few remarks on it. The first paragraph refers entirely to the accounts. You see that the balance available for distribution on December 31 last was £4,910, and perhaps you will kindly turn to the accounts on the other side. The balance-sheet needs no comment. We have raised no more capital, and we have spent nothing on capital account. The profit and loss account shows an expenditure of £2,600, after eliminating the first line of £2,880. On the other side you see that the amount received for telegrams was £10,228. In the corresponding period of 1880 the receipts were less than this amount by £1,170, and the expenses were less by £471; that is to say our expenses have increased £471, but we have realised an extra profit of £1,170 with that £470. The excess profit, therefore, over the same period of 1880 was £700. The question of working expenses to gross receipts we have carefully examined, and we find that they bear a very favourable proportion, and are not more than they should be. I now come to the second paragraph in the report, in which we say, "The receipts are in excess of those for any previous half year since the formation of the Company." The next approach to that half year was in December 1875, the receipts for that period being £9,752, against the present £10,228. I wish, however, to draw your attention to the marked difference between the two periods. In 1875 we had the Carlist war in Spain, and the bulk of our receipts originated from military and diplomatic messages, which, of course, is a very temporary source of revenue. At present the whole of the receipts are due to the increase of activity in trade in Spain. I have put down a few figures to show how this activity has increased in the last years if measured by our receipts. In the half year ended December, 1878, our receipts were £5,741; in the half year ended December, 1879, they increased to £7,405; in the half year to December, 1880, they rose to £9,058, and during the half year ended December, 1881, they increased to £10,228. Now, the difference between 1881 and 1880 is not so great as between 1880 and 1879, but the reason for this is that in last December, 1881, our cable was broken for eighteen days, and we consequently lost a good deal of traffic, otherwise the proportion would, no doubt, have been about the same. As regards the traffic since, that is not a question which really arises to-day at this meeting, but it may be interesting for you to hear that the increase keeps on steadily. In January, 1882, our receipts were £2,055, in February they were £2,109, and in March (estimating yesterday and to-day, for which we have no returns yet), they were £2,280. That is a total for the three months of £6,444, which is equal to £12,888 for the half year, if everything goes on as well during the next three months. The next paragraph refers to the break-down of the cable in November and December last. The cable parted at about 12½ miles from the Spanish coast in eighty fathoms of water. It was found that the cable was laid on a narrow ledge of rock, and the motion of the waves on the cable had severed the outer coating. The ship went out and picked up four miles of intermediate cable, and went out to sea till they got to 90 fathoms of water, where they found the cable perfect. They then cut out the bad piece, and substituted four miles of cable of better type—intermediate cable. That cable is put down now, and we have every reason to believe that it will last longer than the other did, but at the same time it is only right to say that this cable lasted on this ledge of rock for nine years, and consequently has not had a very bad "life." I have brought here the piece that was severed for you to examine. As to the cost of the repairs, it looks rather heavy—£3,180; but you must remember that in October last after the gales a great many of the cables were broken, and there were no ships to repair them. There was not a single suitable ship to be had in England, and we had to go abroad to find a ship. Fortunately, we found one in the north of Europe (Copenhagen), and we had to make such terms as the people imposed on us, because we could not lose our traffic. The ship did her work very well. She got to London a few days after she was chartered, left the Thames on December 11, steamed to Bilbao, 1,100 miles, picked up the cable, mended it, inserting four miles of new cable, and finished the whole operation on the 15th December. Considering the time she spent over it, she made a good bargain, but the weather might have been bad, and she might have been longer. The next paragraph refers to how we paid for these repairs. Of course the question arose how the cost should be dealt with. The directors have always considered that this Company wants strength in the way of having a good reserve. If we had taken this £3,200 out of the reserve fund of £5,500, it would have left only £2,300, and we came to the conclusion that that was too small to face any possible contingency. The directors therefore determined to pay off the whole of these repairs out of the revenue for the half year, with the exception of £300 which we took from the reserve fund to make up the dividend. The reserve fund is now £5,200. This may appear to some people rather hard, but we are satisfied that, for the interests of the Company, it should be so. The next paragraph refers to the distribution of dividend, and a resolution on that matter will be submitted in the usual way. We recommend that the preference dividend shall be paid at the usual rate of 10 per cent., less income-tax, and there will be left for the ordinary shareholders 3s. per share, free of income-tax. The next paragraph states that we expect remittances from Spain (that is, for the last half year) wherewith to pay the dividends by the latter part of April; but I am glad to say that we have received advices that we may expect them by the 5th of April, and we shall distribute the money as soon thereafter as possible. Our cables are constantly being tested, and the result of these tests has enabled our engineer to certify and state that our cables are in excellent electrical condition—in fact, that the insulation is better than when they were put down. The same may be said of the underground land lines, which we put down in 1880 from the Lizard to Falmouth, so as to make Falmouth the terminus instead of the Lizard.

The motion that the report be adopted was carried unanimously.

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SLIP

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for last week amounted to £3,855.

FIRE ALARMS IN WINNIPEG.—The Council of this Canadian town have resolved to establish a fire brigade, and a system of electrical fire alarms.

ELECTRIC LIGHT IN SYDNEY.—The new arcade between King-street and George-street, Sydney, was opened recently. It is lighted by the electric light.

TELEGRAPH EXTENSION IN CANADA.—It is stated that the Great North Western Telegraph Company are about to extend their line as far as La Roche Percée in Manitoba.

ELECTRIC LIGHT IN WASHINGTON.—An electric light company has begun the erection of a building for supplying electric lights. A portion of F-street will be lighted.

ELECTRIC LIGHT IN ST. LUKE'S, E.C.—The vestry of St. Luke's have resolved to obtain tenders for lighting certain streets in their districts by means of the electric light.

THE BLOCK SYSTEM IN INDIA.—The East Indian Railway authorities are making experiments with a view to the general introduction of the telegraphic block system on that line.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March, 1882, amounted to £2,332, against £1,492 for the corresponding period of last year, being an increase of £840.

SOCIETY OF ARTS.—The following papers on electrical subjects are fixed for the subjoined dates, viz.:—April 26, "Telephonic Communication," by Colonel Webber; May 3, "The Fire Risks Incidental to Electric Lighting," by T. Bolas, F.C.S.

REUTER'S TELEGRAPH COMPANY.—The ordinary general meeting of the shareholders of this company will be held on the 26th inst., at noon, at the company's offices. The transfer books of the company will be closed from the 12th until the 25th inst. inclusive.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 7th April, 1882, were £2,580, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

A LONG TELEPHONE LINE.—News from America says that telephonic communication has been effected between Alpena and Bay City, on the telegraph wire between those places. The line worked well, though the distance between the two cities is 130 miles.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company (traffic and steamer) for the month ending March 31st, 1882, amounted to £3,490, against £1,635 for the corresponding period of last year, showing an increase of £1,855.

THE NEW ATLANTIC CABLE.—According to a Reuter's telegram from New York, dated April 8, news had been received in Halifax on the previous day from the Faraday cable ship, stating that the work of laying the new Atlantic cable had been successfully completed.

ELECTRIC LIGHT FOR THEATRES.—Mr. E. W. Goodwin, F.S.A., has written a letter to the Metropolitan Board of Works on the subject of the prevention of fires in theatres, in which he suggests that the lighting of all parts of a theatre should be accomplished by means of electric lights.

DIVIDENDS.—The following dividends have been declared for the past year, viz.: The Company for the Laying and Maintenance of the German-Norwegian Submarine Cable, £1 2s. 5d. per share; Hamburg-Heligoland Telegraph Company, 14s. 7d. per share; and German Union Telegraph Company, £1 5s. 5d. per share.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The directors of this Company have resolved, after placing £37,500 to the renewal fund, to declare an interim dividend for the quarter ending the 31st of March, 1882, of 5s. per cent. on the ordinary, and 10s. per cent. on the preferred stocks, both free of income-tax, payable on the 1st of May.

RANGOON.—"Rangoon," remarks the *Homeward Mail*, "is going ahead. At a recent meeting of the Local Municipality it was agreed to accept the offer of the Eastern Electric Light and Power Company of 50,000rs. per annum to replace the kerosine oil lamps with the electric light. They also accepted the Oriental Telephone Company's offer to establish an Exchange Company."

THE BLOCK SYSTEM.—The North British Railway Company are rapidly extending the block system of signalling on their main lines. It is now in operation between Edinburgh and Berwick, and the company's telegraph staff, under the direction of Mr. Clements, is at present erecting the necessary wires for extending the system to the southern section from Hawick to Carlisle.

ELECTRIC LIGHTING IN BROOKLYN.—*Engineering News* says that an experiment will be made in the eastern district of lighting a portion of that section of Brooklyn (New York) with electricity at the city's expense. Parts of Broadway, Grand, Fourth, and Fifth-streets will be selected for the experiment. 5,000 dollars have been set aside to pay the expense of maintaining forty-four electric lights.

TELEGRAPHIC EXTENSION IN WALES.—The Post Office are about to erect a new line of telegraph from Swansea to Haverfordwest, *viâ* Pontardulais, Crosslands, Carmarthen, and St. Clears. It is understood that this line is not intended to facilitate local communication, but to carry new main wires from London, which are intended to supplement the present telegraphic facilities between London and Ireland *viâ* Fishguard.

THE SOUTH AFRICAN TELEGRAPH.—The Eastern Telegraph Company notifies an interruption of the South African Company's Zanzibar-Mozambique cable. The company's cable-repairing steamer will be immediately despatched from Zanzibar to restore the communication. Telegrams for the Cape will be sent on by steamer, which leaves Zanzibar for Mozambique in a few days, and the messages will also be transmitted by wire when the cable is repaired.

ELECTRIC LIGHT FOR NEWCASTLE-ON-TYNE.—At a recent meeting of the Town Council of this town the following resolution was carried unanimously:—"That a special committee be appointed for the purpose of taking into consideration, and reporting to the Council, on the advisability of lighting the public streets and buildings of the borough with the electric light, especially with the view of utilising the present engine power at the Quayside."

NEWS FROM TASMANIA.—The Government have accepted the tender of the Australian Electric Light Company for supplying, at a cost of several thousands of pounds, a complete torpedo equipment, to complete the defence system of the Colony. Colonel Scratchley will see that the contract is

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properly carried out. The Government has resolved to co-operate with the other Colonies in the matter of intercolonial weather telegrams.—*Colonies and India.*

American Patents.—An American contemporary says:—"Taking the subject of electrical patents as a whole, the most activity has been exercised with the following during the past three years: 1, electric lights; 2, dynamo machines; 3, telephones and their appliances. Prior to January 1st, 1878, there were only twenty patents on electric lights; July 1st, 1881, there were 192. Prior to July 1st, 1879, there were only nineteen dynamo and magneto machine patents. July 1st, 1881, shows 111."

Electric Light at Eastbourne.—The Lighting Committee of the Eastbourne Local Board having recommended that the offer of the recently formed local Electric Light Company to light the parade with 13 large Brush lamps, at a cost of about £520 per annum, or £187 in excess of the present cost of the 77 gas lamps in use, be accepted, the recommendation was warmly discussed by the Board. In the end it was agreed to negotiate further with the Company, with the view of obtaining a reduction in the terms.

Coupons.—The coupons of the Submarine Cables Trust, due on the 15th instant, will be paid by Messrs. Glyn, Mills, Currie, and Co., between 10 a.m. and 2 p.m. The coupons must be left for examination three days previous to calling for payment. The Direct United States Cable Company notify that the interest due the 15th instant on their Six per Cent. Debenture Loan will be paid at the Consolidated Bank, Threadneedle-street, E.C., where coupons should be left for examination three clear days before applying for payment.

Electric Light in Malta.—According to the *Malta Standard* the preliminary experiments with Brush lamps supplied by the Eastern Electric Light Company as street lights have terminated, the lamps having given satisfaction. The company's representative (Chev. E. Rosenbusch) has, says the same authority, handed in a tender for lighting Strada Reale, the whole of the grand harbour, and any other part of Valetta; and we trust soon to see again the Brush light shine in darkness and with improved chances of success under a permanent installation.

Quick Work.—On Thursday last a letter was received by Messrs. Crompton and Co., electric light engineers, asking them to light Woolpit Church, in Norfolk, for Easter Sunday. The firm wrote on Thursday evening to their Norwich engineer, Mr. S. Baynes, giving the necessary instructions. He succeeded in taking over, installing, and getting to work a set of tackle, and the church was successfully lighted for the evening service on Easter Sunday. As Friday and Saturday were the only two working days, and as traffic was greatly impeded on those days by the holiday makers, this is smart work.

Electricity and the Electric Telegraph.—This was the subject of a recent lecture given at the Bethnal Green Free Library, by Mr. Robert W. Johnston, postmaster of the Eastern Central district. The lecture, which was of a popular character, was illustrated by specimens of most of the instruments in use by the Post Office, lent by the Postmaster-General for the occasion, as well as by a working model of the pneumatic tube system, telephones in circuit, and some experiments with the electric light, conducted by Mr. M. Cooper, of the Electrician's Department of the Post Office.

Great Northern Telegraph Company.—The working account of the Great Northern Telegraph Company for the year 1881 shows that the total traffic receipts reached £236,060 14s. 2d., while £6,336 12s. 2d. was derived from interest, and £9,962 14s. 6d. from sundries. The total expenses were £74,254 13s. 10d. Interim dividends, amounting to £75,000, have been paid, and an extra dividend of 5s., amounting to £37,500, is now notified, leaving, after additions to the reserve and renewal fund of £55,555, to the pension fund £1,111, and the payment of £1,500 to the directors, the sum of £19,688 18s. 7d. to be carried forward.

Oriental Telephone Company.—A general meeting of this company will be held at the Cannon-street Hotel on Wednesday, the 19th instant, at 12 noon. According to the report of the directors their attention has been chiefly devoted to carrying out the company's concessions and constructing the various exchanges. Considering the distant fields of the company's operations, and the negotiations which had to be undertaken with governments, municipalities, and others, the progress has been satisfactory, and promises to be still more so. It appears that 428 subscribers have been obtained in India, Honolulu, and Alexandria, and the Cairo Exchange will be shortly opened with fifty more to begin with. The gross revenue from various sources has been £1,377, which it is proposed to use in reduction of capital expenditure.

Royal Society of Edinburgh.—At the ninth ordinary meeting of this society, held last week, a note on "Atmospheric Electricity," by Professor C. M. Smith was communicated by Professor Tait. Professor Chrystal communicated a paper by Mr. A. Jamieson on the subject of electric lighting, giving the results of recent tests as to the fall of resistance in Swan's lamp, with increase of electromotive force and ratio of candle-power to work expended. In the course of the discussion which followed this paper, Sir William Thomson, alluding to the importance of ascertaining how long a lamp would last at a certain power, pointed out that slight inequalities in the fibres used in these lamps constituted the evil which caused one lamp to break down at one point and another at a different point. Two important matters to be determined were the quality of the carbon and the uniformity of the film from end to end.

Electric Light in India.—The *Bombay Gazette* of the 16th ult. says:—"Last evening the electric light was tried at the Crawford market, and the experiment proved very successful. Three lamps were placed where the roads meet, and eight or nine were put up in the markets. The result was that a strong, pure, and soft light filled the building and was diffused over the road. The lights were on the Brush system, and were supplied by the Eastern Electric Light and Power Company. The trial having proved so satisfactory, there is a possibility of the municipality using the electric light for the markets, which may in that case be kept open until a later hour than they are at present. The municipality may also introduce the light into the Bandora slaughter houses. The experiment last evening was watched by the municipal commissioner, and was conducted under the supervision of Major C. H. Strutt, managing director of the Eastern Electric Light Company."

The Electric Light in the City.—With reference to some recent remarks made by the chairman of the Commissioners of Sewers as to the large increase in the cost of Messrs. Siemens' tender for renewing the lighting in their district of the city for a further term of one year, Dr. C. W. Siemens writes as follows:—"It would not be difficult to show that in hiring a warehouse in the most crowded portion of the city of London, and in appointing a special staff of superintendents for the working of a limited number of lights spread over a single line, the expenses are incompar-

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ably greater than would be the case if permanent engines were laid down; and instead of a single line of lights, the illumination were extended to a compact district, including a system of private lighting to which it is well known the gas companies look chiefly for their profits. If gasworks had to be established under the same unfavourable condition of being placed in the City, subject to a short notice to quit, and with the practical prohibition to supply private customers, the balance of expense would be largely in favour of the electric light, notwithstanding our increased tender."

Johnson v. the British Electric Light Company.—This was an action for an injunction to restrain the continuance of a nuisance which the plaintiff stated was caused at his house, No. 11, Savile-row, by the operations of the company. It was heard by Vice-Chancellor Hall on the 5th instant. The nuisance was alleged to be twofold—first, by causing the exhalation of gases which were believed to be injurious; and, secondly, by the noise made by the engine of the company, which it was said worked both day and night. —Counsel for the plaintiff submitted that it was only reasonable that the company should undertake not to work the engine later than midnight.—For the defendants, however, it was pointed out that they had entered into contracts to supply the light to various premises, including two clubs in the neighbourhood, and that it would paralyse their business to stop so early; but that they offered to undertake to stop at two a.m.—The Vice-Chancellor thought that at this time of year, when many persons did not go to bed before that hour, this offer was reasonable, and the motion, accordingly, was directed to stand over until after the Easter Vacation on such undertaking being given, the company, of course, not thereby admitting that any nuisance existed.

How Facts are Distorted.—The *Globe* of the 11th instant says:—"An outbreak of fire, which was happily not attended with any serious results, occured last night at the Crystal Palace. At about nine o'clock, when an enormous number of persons were promenading in the centre transept, one of the electric burners, at the Crompton electric light stall, suddenly exploded, in consequence of a defective carbon, and instantaneously set fire to some hangings. Great excitement and terror were immediately displayed by the crowd; but Superintendent Butt, who was standing near, promptly threw a bucket of water upon the flames, and extinguished them. A large number of the Palace firemen were on the spot with scarcely a moment's delay." The simple facts so wondrously distorted are as follow:—Mr. Bürgin, whilst exhibiting a new projector for military purposes, dropped a piece of hot carbon on to the cotton cloth in front of the gallery, and this set it on fire. As, however, some of Messrs. Crompton and Co.'s men were at hand, they beat it out with their hands in a few minutes, long before any water could be brought. How an "electric burner" can "explode" we may leave to our contemporary to explain. We think its reporter must be confusing gas with electricity.

An Electric Light Tower.—Mr. William Golding, of New Orleans, U.S.A., has invented a new form of tower for electric lighting purposes which he proposes to erect in his native city. Mr. Golding dispenses with stagings and the usual machinery of tower building, and raises his tower into the air by additions made at the bottom. The tower is a cast-iron cylinder, built up of short sections five hundred feet high if need be, and kept vertical while in process of erection, and afterwards by means of guys. The top sections, to which the lamps are to be permanently attached, are put together first, and by means of an ordinary derrick are set vertically over a hydraulic press placed upon the intended foundation of the tower. The hydraulic lift raises the top sections until a new section, say five feet long, can be set underneath. While the lift is returning to admit a new section the raised tower is held in position by a clamp and kept vertical by means of the guys which are simultaneously fed off by a wormwheel gear as the tower is pushed up. When the new section has been securely bolted on, the whole is lifted another length; and thus by successive lifts and additions at the bottom the tower is raised until the required altitude is attained. Each section of the tower will be bored out before it is put in place, and have a diameter sufficient to allow the easy passage of a circular platform carrying the lamp trimmer, who will be lifted to the top of the tower by means of a piston operated by compressed air supplied by pumps or a rotary blower. The inventor thinks that the pressure need never exceed half a pound to the square inch. The cost of a five hundred foot tower complete (without the lamps) raised in the way described is estimated at about 30,000dols.

Electric Lighting.—In a further letter to a Bristol paper Mr. F. W. Griffin, having previously alluded to the ill-effect of gas on human life and the beneficial effects of electric light, as stated in our note of last week, goes into the subject of the baneful effects of gas lighting on the bindings of books, goods exposed in shop windows, &c. Besides the evil effects produced by the great heat given off by gas, Mr. Griffin alludes to a further source of injury. He says:—"The large amount of water generated by the gas flame adds to the mischief. Sixty burners will produce on the lowest computation two gallons of water per hour, hence in a November evening many large shops filled with delicate goods will have a nine-gallon caskful of water thrown into their atmosphere in the form of steam, to condense on any cool surface, as we often see it trickling down the windows in winter. But worse remains behind. The sulphur, always present in gas in larger or smaller proportion according to the character of the coal employed, burns into sulphurous vapour, which passes in the air to the state of oil of vitriol. The eminent chemist, Dr. Prout, exposed water in a drawing room in which gas was burnt and found that it absorbed sufficient of these vitriolic emanations to redden blue litmus and show the presence of free sulphuric acid. The fumes from gas will indeed in the long run discolour every sort of fabric, rust metals, rot gutta percha, and reduce leather (as in the binding of books) to 'a scarcely coherent powder with a strongly acid taste.'" After referring to the evidence of the librarians of the Athenæum Club, London Institution, &c., as to the rotting of the bindings of books kept in rooms lighted by gas Mr. Griffin says:—"Drapers know to their cost how the edges of pieces of dyed fabrics become faded and rotten when kept long on the upper shelves of gas-lighted shops; no plant will grow in a room where gas is burning, and cut flowers quickly wither; while those who work long and habitually in gas-lighted rooms become blanched and sickly. From all these manifold evils electricity will deliver us. The little glass globes of the Lane-Fox and other 'incandescent' lights give off only a gentle warmth, and no trace of contamination, the carbon thread glowing in an absolute vacuum. A cluster of these lights could be kept burning brilliantly for a month in an air-tight case filled with the most delicate materials without doing them the slightest injury. Hence when our dining rooms, our drawing rooms, our studies, and our offices are thus lighted, as they eventually will be, their atmosphere will remain as cool and pure as if they were still flooded with the departed daylight, and our health and comfort will benefit accordingly."

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CRYSTAL PALACE EXHIBITION.

King's Railway Signals.

The applications of electricity as an auxiliary to steam has enabled our railway trains to run with greater speed and safety. Very few except those directly connected with railway work know the immense services electricity is called upon to perform, and for the most part does perform well. Mr. Langdon, in 1877, gave us a book of between 300 and 400 pages treating this subject, and since then many new applications have been made, some going so far as to supersede the ordinary locomotive by electric transmitters. Professor Ayrton recently urged the claims of electric railroads before the Royal Institution, but it will at any rate be some time before such roads become general in England. Meanwhile we have other developments of electrical applications to signalling purposes. In the exhibition, Messrs. Saxby and Farmer, Messrs. Sykes and Co., and the Electric Railway Signal Co. show models of attempts made in this direction. We herewith illustrate the model of the latter company. The signal is the invention of Mr. King, and is in charge of T. Kirkland, jun., engineer to the company.

The principle of this patent is to render block signalling automatic, but it can also be used for hand signalling if desired.

The model exhibited at the Crystal Palace has been designed to show the possibility of working the system under many varied conditions.

On the model are three signal boxes (Fig. 1), which may be called A, B, and C, placed by the side of rails, representing a main and branch lines. A and B are supposed to be any distance apart, B and C to be within a short distance of one another. In connection with B and C is a switch lever (worked by hand of signalman at B), which moves the points so as to allow a train to pass on to the main or branch lines, as may be required. In the signal box A there is a clock arrangement, with a finger, capable of indicating time up to 15 minutes, which shows to the driver of an approaching train the length of time which has elapsed since the last train passed this box. On his train passing over the treadle in connection with this box the clock finger is at once put back to zero on the dial, going on again immediately the train has passed. In connection with the clockwork (but not shown on model) could also be an automatic register for indicating the number of trains which passed the box in a day, the exact time each does so, and whether the signals were up or down at the time of passing. There is also inserted a semaphore signal, which is put up to "danger" by mechanical means on a train passing over the treadle in connection with box A, and which will remain up until it is put down by the action of an electro-magnet, which exerts its attractive force on the electric circuit being completed by the train passing over the treadle connected with the next signal box B. On the other side of the signal box A this arrangement is duplicated, and is worked in the same way, being put up by a train passing over the treadle on the other line, but is put down by an ordinary bell-push to show how a signal can be put up or down by this means.

The signal box B is fitted with two semaphores, S S_1 (Fig. 2), the one being above the other. The top one, S_1, is to give information to pointsmen or others whom it may concern that a train has passed into the section of line between A and B, which it does by going up when a train passes over the treadle at A, as that completes the electric circuit which causes the armature in B to be attracted, and allows the signal to rise up. When a train passes out of the section by going over the treadle at B, this signal is put down by mechanical means. The lower semaphore S is the driver's signal, and is put up by mechanical means on a train passing over this treadle, and down again when the train moves out of this section by its passing over the next treadle, when it would put up another signal behind it, and so on along the whole line.

The signal-box, C, is fitted with a semaphore on the opposite side to those described in A and B, as it has to indicate whether the branch line is clear or blocked, and is actuated by hand in the ordinary way by the switch lever before mentioned. When this lever is in its normal condition, showing the main line clear, the semaphore in C remains locked at danger. When the handle is pulled over, thus altering the points to admit a train on to the branch line, it locks the semaphore in C down, showing the branch line clear, at the same time locking the driver's semaphore on the main line in signal-box B at danger, and thus preventing any main line train proceeding.

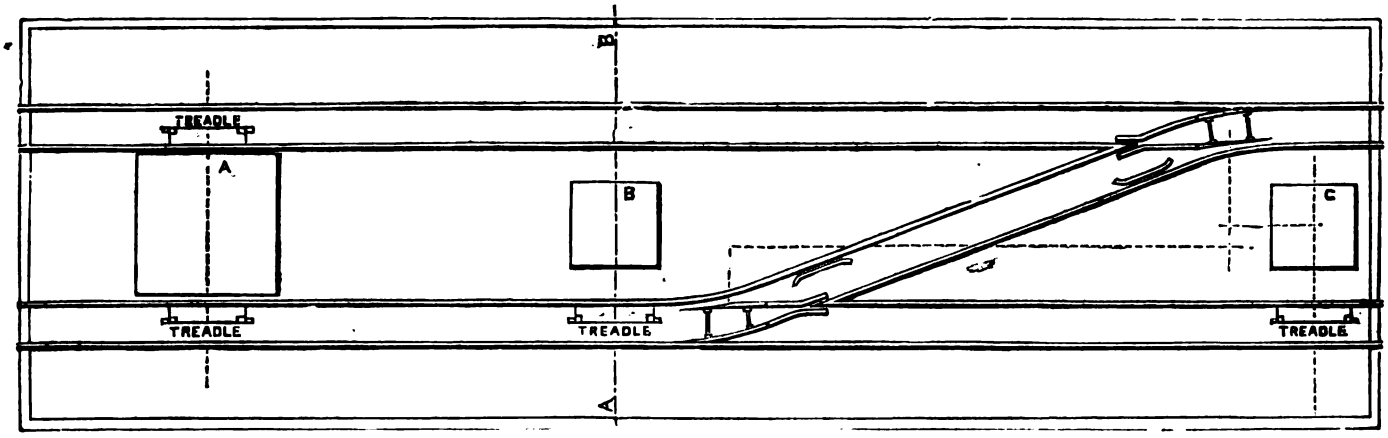

Fig. 1.—Plan of Rails and Stations.

The model thus shows:—

1. How a signal may under this system, be put either up or down by electricity at any distant point on a train passing over any given point.

2. How a signal may be put either up or down by electricity at any distant point by hand, with an ordinary bell-push placed at any convenient point.

3. How a signal may be put either up or down by mechanical means by a train passing a signal box.

4. How a signal may be put either up or down by hand in the ordinary way.

5. That the signals can be interlocked with the points. It should also be noticed that the signals go either up or down at one pre-determined rate whether an express or slow train passes over the treadle, thus avoiding any liability to breakage, as would be the case were the signals rigidly connected with the treadle.

The rocking shaft actuating the signals, which is worked by the train passing over the treadle, is so made as to allow for contraction and expansion or adjustment to rails, without interfering with the working. The semaphores are so constructed as to show a red light at night when the line is blocked and a white light when clear. No signal could be altered by the signalman without tampering with the works, which could easily be boxed in. All electrical connections are placed inside the signal boxes.

The electro-magnets in the model are excited by the current produced by Fuller's patent mercury-bichromate batteries, which is conveyed by wires in the ordinary way.

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The description given above is of the model now being shown at the Crystal Palace.

This system admits of another way of working not shown by the model. A signal can be put both up and down in any signal-box by electricity either by the train passing over treadles or by hand of signalmen, or, if desired, only by the mutual consent of two or more signalmen in distant boxes.

The principle of the mechanism is that the treadle which the flanges of the wheels of a passing train depress is in connection with a rocking shaft, to which at either end are welded levers, one being shorter than the other, the shorter one being in connection with the treadle, the other being in the signal-box. All electrical connections are placed here, and this lever, being fitted with suitable contact pieces, makes or breaks contact, as it is depressed by a train or allowed to rise again. Supported by this lever in the box is a balance-weight, which, in the normal condition of the treadle is held up by means of a spiral spring. When this spring is lengthened by the lever being depressed (*i.e.*, by a train passing over the treadle) the balance-weight is free to fall by gravity from rest, which determines its rate of motion. When the balance-weight falls it pulls over a three-armed rocking lever, by doing which it allows the signal to rise or fall, as may be required, the signal being out of balance one way or the other, and the amount it is out of balance determines its rate of motion. As soon as the three armed lever is pulled into this position it is held there by a catch which is attached to the armature of an electro-magnet. Directly the train has passed, the aforementioned spiral spring pulls the balance-weight again into its normal position, and as it is attached by a slotted link to the three-armed lever it leaves this three-armed lever and signal free to return to their original position directly the armature is attracted by the electro-magnet,which it is when the electric circuit is completed by the train passing the next treadle, there being on one arm of the lever a balance-weight for this purpose.

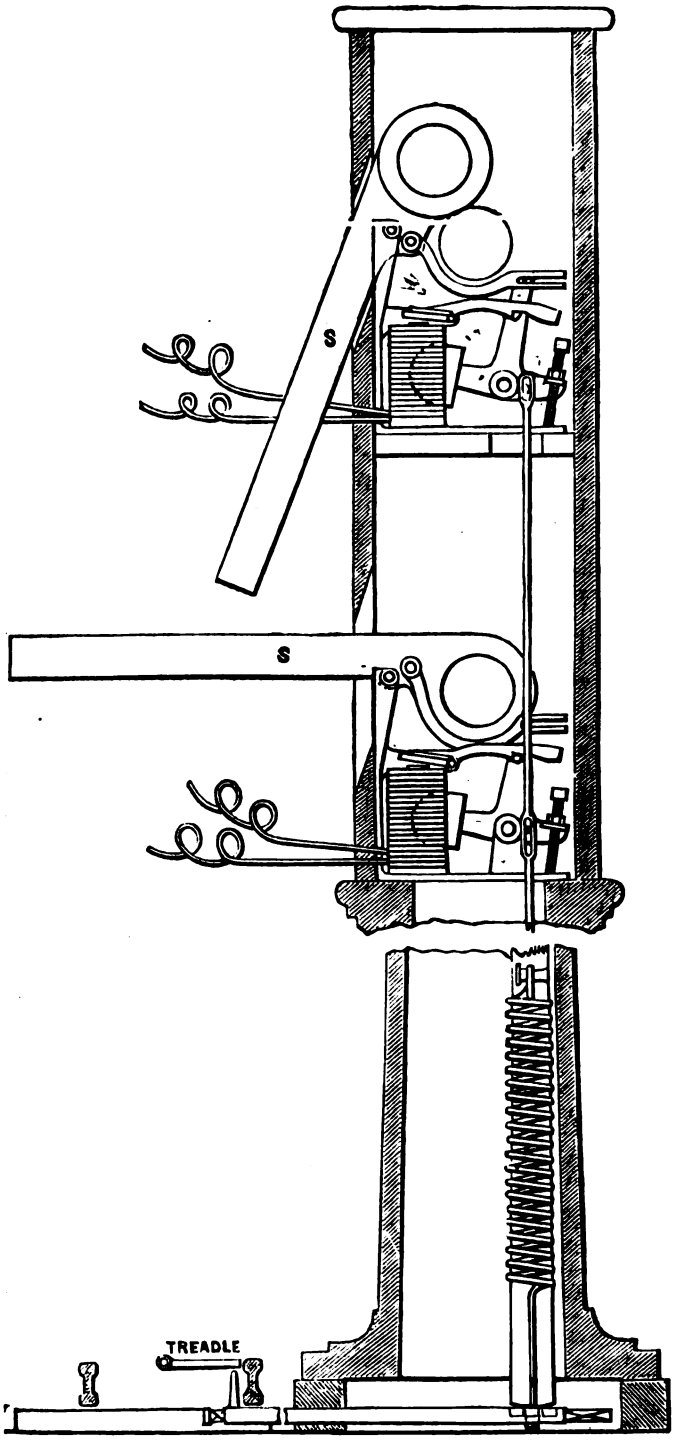

Fig. 2.—King's Signalling Apparatus.

The clock finger is driven by a friction disc, which remains in gear so long as no train passes the treadle, and it is not more than fifteen minutes since the last train passed. When a train passes over the treadle it relieves the pressure producing the friction, when the disc, to which is attached the finger and a balance-weight, becomes a loose pulley, the balance-weight immediately pulling it back to zero on the dial. When the finger indicates that it is fifteen minutes since the last train passed, the pressure is relieved by the lever producing it falling into a slot, which allows the clock to go on, but holds the hand stationary until the next train passes, when the finger is again put back to zero and recommences work.

THE INFLUENCE OF STRESS AND STRAIN ON THE ACTION OF PHYSICAL FORCES.*

BY HERBERT TOMLINSON, B.A.

The temporary alteration of electrical conductivity which can be produced by longitudinal traction was measured for all the metal wires used in Part I. both in the hard-drawn and annealed condition, and, in addition, for carbon and nickel, by the following method:—The wires were suspended in pairs of equal lengths in an air chamber 4 feet in length and 4 inches inner diameter. This vessel, which consisted of two concentric cylinders containing a layer of water 1 inch thick between them, stood upright on a stout table. The ends of the wire to be tested, and of the other wire, which will be called the comparison wire, were clamped into three brass blocks which rested upon a support of hard wood placed on the top of the chamber. One of the blocks was twice the length of each of the other two, and into this was clamped one end of each of the wires; the other ends were clamped into the other two blocks. The blocks were provided with terminal screws, and a "Wheatstone bridge" was formed, having four branches consisting of the wire under examination, the comparison wire, and two sets of resistance coils, each of about 100 ohms, but capable of variation by such small amounts as ·1 ohm at a time. These resistance coils were connected by caoutchouc-covered copper wire, several feet in length but of small resistance, to two of the brass blocks, and were also united to each other by a platino-iridium wire having a resistance of ·1 ohm, which was stretched along a scale divided into millimetres, and was traversed by a sliding piece which, by means of a suitable spring and catch, could be readily clamped to any part of the wire. By means of the resistance coils and the platino-iridium wire an alteration of less than one in a million could be measured. As the change of resistance was in general very small, it was necessary to take every precaution to avoid sudden changes of temperature. It was necessary also to keep the galvanometer-circuit always closed in order to avoid errors which would otherwise have arisen from thermo-electric currents. A single Leclanché cell was employed for the current-motor, and with this it was possible in a large majority of cases to measure with the aid of a delicate reflecting galvanometer an alteration of resistance not exceeding one in a million. The wire to be strained was provided with a movable pulley 2 inches in diameter, to which was attached by means of a stout wire passing through a small aperture in the table a scale pan, and both wires were, before suspension in the air chamber, surrounded with caoutchouc tubing, silk, or other insulating material.

* Abstract of a Paper read before the Royal Society.

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The electrical resistances of all the substances which were examined were, with the exception of nickel, increased by temporary longitudinal stress. With nickel, however, of which metal a wire nearly chemically pure was at length with difficulty procured, the resistance was found to *diminish* under longitudinal stress not carried beyond a certain point; but after this point had been attained further stress began to increase the resistance. The effect on nickel appears still more remarkable when we reflect that the change of dimensions produced by the stress, namely, increase of length and diminution of section, would increase the resistance. The *specific* resistances of all the substances, except nickel and aluminium, were increased by temporary longitudinal stress. With aluminium and nickel the specific resistances were *diminished* by stress not carried beyond a certain limit. With nickel and carbon it was necessary to introduce slight modifications of the original method of determining the influence of stress on the resistance. With carbon, though the increase of resistance produced by a given amount of stress was greater than was the case with any of the other substances except tin and lead, this was not so with respect to the specific resistance.

In the next table will be found the mean results of the different experiments made with the various substances in the annealed condition.

Name of substance.	Increase of resistance per unit produced by a stress of 1 grm. per square centim. — signifies decrease of resistance.	Increase of resistance per unit which would be caused by stress sufficing to double the length of the wire. — signifies decrease of resistance.	Increase per unit of specific resistance which would be caused by stress sufficing to double the length of the wire. — signifies decrease of resistance.
Iron	2111×10^{-12}	4·180	2·618
Platinum	2285	3·404	2·252
Zinc	4406	3·379	2·113
Tin	10546	2·920	1·630
Lead	17310	2·885	1·613
Silver	4272	3·851	1·531
Copper	2310	2·713	1·005
Carbon	9248	2·480	0·980
Platinum-silver.	2346	2·464	0·624
German-silver...	1523	2·018	0·226
Aluminium	1896	1·276	−0·262
Nickel*	−3216	−6·994	−8·860

The numbers given in the above table are calculated on the assumption that the alteration of resistance is proportional to the stress; this was found nearly, but not quite, the case.

One of the most remarkable features discernible in the table is the similarity of the order of the metals, as given in the last column, to that of the table of "rotational coefficients" of metals recently given by Professor Hall; indeed, so striking is the relationship in the case of the metals, iron, zinc, aluminium, and nickel, that there would appear to be no doubt that a series of experiments made with a view of determining the effects of mechanical stress and strain on the "rotational coefficients" would be of the greatest value.

Another point to be noticed is that the alteration of the specific resistances of the alloys brass, platinum-silver, and German silver is much less than that of the several constituents of these alloys, and at first sight there would appear to be some relation between the alteration of resistance caused by change of temperature and that due to mechanical stress; but it has been proved by these and other experiments that the increase of resistance caused by rise of temperature is in some cases one hundred times that attending the same amount of expansion by mechanical stress; and, apart from the fact that with nickel and carbon the effects of change of temperature and of longitudinal stress are of an opposite nature, it is evident that the former are to be attributed to other causes than mere expansion.

The influence of permanent extension on the temporary alteration of resistance caused by longitudinal stress was examined, and the results obtained verified the statement previously made, that "the elasticity of a wire is diminished by permanent extension not exceeding a certain limit, but beyond this limit it is increased." The effect of permanent extension on the alteration of resistance which can temporarily be produced in nickel by traction is very remarkable.

Compression was proved to produce on the electrical resistance of carbon a contrary effect to that caused by extension; this statement applies to the alteration of specific resistance as well as of the total resistance.

Stress applied in a direction transverse to that of the current was also found to produce in several metals both temporary and permanent alterations of resistance of a nature opposite to those resulting from longitudinal traction. The time during which the stress was allowed to act exercised with strips of tin and zinc a large influence on the amount of the temporary alteration of resistance which was produced by the stress. In the case of the strips of tin and zinc also, the alteration of resistance seemed to be very much greater than when longitudinal stress was applied to these same metals in the form of wires.

Stress applied equally in all directions by means of an hydraulic press was proved to diminish the resistance of copper and iron; and the experiments showed that the lowering of the temperature of the freezing point of water can be accurately and readily measured by observations of the change of electrical resistance of a wire. These experiments also furnished still further proof that the change of resistance of a metal wire caused by rise of temperature is due almost entirely to other causes than mere expansion.

Experiments on the permanent alterations of resistance which can be produced by stress furnish valuable information respecting the "limit of elasticity" of metals.

There are two "critical points" in every metal at which sudden changes occur in the ratio of the permanent extension due to any load and the load itself. The first of these points fixes the position of the true limit of elasticity, and the second that of the "breaking-point." With iron there are three, and perhaps more "critical points."

The total resistance of most metals is permanently increased by permanent longitudinal extension, but with nickel the *total resistance* is permanently *decreased*, provided the extension does not exceed a certain limit. Beyond this limit further extension causes the resistance to increase.

The rate at which a wire is "running down" under the influence of a load can be very advantageously studied by observing the permanent increase of resistance produced by the load.

If P be the "breaking-load" of a metal, and p be the load actually on the wire, the decrease per unit of the velocity of the increase of resistance is inversely proportional to $P - p$; so that the breaking-load of a wire can be calculated from observations of the rate of increase of resistance when a loaded wire is "running down."

The above-mentioned proportion is constant not only for one and the same metal, but for all metals.

The small effects which can be produced by permanent extension, hammering, and torsion on specific electrical resistance were very fully investigated, and are shown in the paper by a series of curves. All the metals examined, except iron and nickel, have these specific resistances increased by strain caused by the above-mentioned processes, provided the strain does not exceed a certain limit; beyond this limit further strain decreases the specific resistance. In the case of iron and nickel, on the contrary, the specific resistance is at first *decreased* and afterwards increased.

The effect on the resistance of annealed steel produced by heating and suddenly cooling was also studied, and it was proved that if the steel be heated to a temperature under "dull red," sudden cooling *decreases* the resistance; whereas if the metal be heated up to or beyond "dull red," sudden cooling *increases* the resistance; the strain, therefore, caused by the process, and that resulting from purely mechanical treatment, are similar as regards their influence on the electrical resistance.

In order to make certain small corrections rendered necessary by the changes of density of the metals after they had been subjected to extension, hammering, or torsion, these changes were very carefully measured, and were found to be in every case small.

The amount of recovery of electrical conductivity produced by time in wires, which are in a state of strain, is shown in the paper for several metals by a series of curves, and these exhibit most conclusively the superiority of platinum-silver over German silver when an accurate copy of a standard resistance has to be kept for a long period of time; in fact, of all the metals tested, German silver showed the most marked recovery of conductivity, and platinum-silver the least.

The recovery of electrical conductivity is in all cases attended with recovery of longitudinal elasticity and of torsional rigidity.

A full examination of the influence of permanent strain on the susceptibility to temporary change of resistance from change of temperature showed that metals may be divided into two classes. In the first of these classes, which includes iron, zinc, and platinum-silver, the strained wire is *most increased in resistance*

* The numbers given opposite this metal are calculated from the results obtained for stresses carried up to the above-mentioned limit, and as in the case of the other substances represent the alterations which would ensue if the changes of resistance were proportional to the stress for any amount of the latter.

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by rise of temperature up to a certain limit of strain, whilst beyond this limit further strain diminishes the first effect. In the second class, which comprises copper, silver, platinum, and German silver, the strained wire is *least increased in resistance* by rise of temperature, but, here again, after a certain point of strain has been reached, the first effect begins to be diminished. It will further be shown in Part IV. that there must be some close relationship between the thermo-electrical properties of strained and unstrained metals and their susceptibility to change of resistance from change of temperature, and that strain of any kind, whether produced by purely mechanical means, such as traction, hammering, and torsion, or by the process of tempering, renders a piece of metal thermo-electrically positive or negative to a similar piece of metal unstrained, according as the strained piece is caused to be less or more increased in electrical resistance by rise of temperature.

After some trouble means were found of measuring with considerable accuracy at 100deg. C. the alteration of electrical resistance due to temporary longitudinal traction, and the experiments led to the belief that the elasticity of iron and steel is not temporarily but *permanently* increased by raising the temperature to 100deg. C. Subsequently direct observations of the elasticity made in the manner described in Part I, but on shorter lengths of wire, placed in an air-chamber, the temperature of which could be maintained constantly at 100deg. C., proved beyond a doubt that if M. Wertheim, to whom we owe so much of our knowledge concerning elasticity, had examined the elasticity of iron and steel after these metals, tested at the higher temperature of 100deg. C., had again cooled down to the lower one, he would have found that what to him *appeared* in the case of these metals* to be a *temporary* increase of elasticity was *really* a *permanent* one, and if the wires used had been tested several times, first at the higher and then at the lower temperature, he would have also found, *provided sufficient rest after cooling had been allowed*, that the elasticity of both iron and steel is *temporarily diminished* by raising the temperature to 100deg. C.

Not only is a comparatively large and permanent change produced in the elasticity of iron by merely raising the temperature to 100deg. C., but in the case of well-annealed iron wire there is sometimes an enormous change produced in the ductility (in one specimen the ductility was diminished 50 per cent.) by the same process; and since very appreciable effects have been proved to be brought about in the same manner in the magnetic inductive capacity, the specific resistance, and the thermo-electrical properties of iron and steel, it would appear that researches on these properties might lend valuable aid in investigations on the liability of wrought-iron axles to fracture, which is produced by sudden changes of the temperature of the air.

It was further noted that shortly after the iron or steel has been heated and then cooled, there is less elasticity than when a rest of some hours has been allowed, and in fact we have in the case exactly the same kind of restitution of elasticity as we have seen takes place after a wire has received mechanical extension. With nickel the increase of elasticity produced by rest after cooling is still more remarkable.

The effects of very slight mechanical strain, and of the strain caused by raising annealed iron or steel to 100deg. C., and afterwards cooling, on the torsional rigidity of these metals were next examined, and it was shown that the torsional rigidity is affected in a precisely similar manner to the longitudinal elasticity, both by raising the temperature to 100deg. C., and then cooling, and by the strain resulting from slight mechanical traction. On the whole, it was seen that as regards either purely mechanical strain, or that caused by tempering, there are for iron and steel *three* critical points: very slight strain increasing, moderate strain diminishing, and excessive strain again increasing both the torsional and longitudinal elasticity.

The temporary alteration of susceptibility to change of resistance from change of stress, which is effected in the case of nickel by raising the temperature to 100deg. C., is as remarkable as the susceptibility itself, and the maximum diminution of resistance which could be produced by stress when the metal was at the temperature of the room was actually *more than twice* that at 100deg. C.

The alteration of electrical conductivity which can be produced by magnetisation was carefully studied, and a full account of the modes of experimenting, of the apparatus employed, and the precautions adopted will be found in the paper. The substances examined were iron, steel, nickel, cobalt, bismuth, copper, and zinc, and in all cases, except that of copper, it was proved that longitudinal magnetisation increases the electrical resistance, whether the substance is in an annealed or unannealed condition. With copper wire no trace of change of resistance could be detected when the wire was under the influence of a powerful electro-magnetic solenoid. In the case of zinc, which was in the form of foil, no alteration of resistance was discernible until the action of the solenoid was supplemented by that of a stout iron core, which was placed inside the solenoid and round which the foil was wrapped. In the next table will be found the increase of resistance per unit produced in the different substances by an absolute electro-magnetic unit of magnetising force, when the magnetisation is longitudinal.

Name of metal.	Condition.	Diameter in millimetres.	Increase of resistance per unit produced by unit magnetising force.
Iron	Annealed	0·94	2335×10^{-8}
Steel	Annealed	0·85	1500
Steel	Unannealed	2·33	1137
Steel	Very hard	2·33	70
Nickel	Annealed	1·05	8070
Nickel	Unannealed	7·00	4343
Cobalt	Unannealed	7·50	628
Bismuth	Unannealed	3·30	21

Of all the metals examined, annealed nickel was by far the most affected by a given amount of magnetising force.

The increase of resistance produced by magnetisation can be very accurately represented by the formula $\gamma = a.\alpha + b.\beta$; where γ is the increase of resistance, α the magnetising force, β the induced magnetism, and a b constants for the same substance when the same amount of current per unit of area flows through the substance.

When different strengths of current are used in measuring the resistance of annealed iron, the alteration of resistance caused by a given magnetising force increases with the amount of current per unit of area which flows through the substance. The induction current produced by the magnetisation of the iron in a coil surrounding the latter is also greater when a current is flowing through the iron than when it is not.

In some remarks made in the paper on the nature of the alteration of resistance which is produced by magnetisation, it is stated that, "had the nature of the change of resistance been the same for longitudinal mechanical stress as for longitudinal magnetisation in the case of *all* metals, there is nothing in the actual amount of alteration that might not lead us to suppose that the change of resistance from the latter cause is due to mere rotation of the molecules considered simply as molecules without regard to the electric currents, which, according to Ampère's hypothesis, are constantly circulating round these molecules. But when we find that with nickel, longitudinal traction, which must also cause to a certain extent rotation of the molecules, but without *magnetic polarity*, actually produces decrease of resistance, we are probably right when we conjecture that the change of resistance resulting from magnetisation is in a great measure due to the fact that the current used in the 'bridge' is encountered by a set of molecular currents circulating all more or less in the same direction, and in planes more or less at right angles to the direction of the 'bridge'-current, according as the magnetism induced is greater or less." These molecular currents would cause the current passing through the substance to flow spirally, and the effect would be aided by the action of the magnetising force itself, which action would go on increasing with increase of force, even when no appreciable further increase of induced magnetism took place. Since Professor Hall has proved that such action is possible, and that nickel, iron, and cobalt are very conspicuous in this respect, we have some support for this view.

The "circular" magnetisation which any magnetic substance undergoes when a current is conducted through it seems to have very little or no appreciable effect on the electrical resistance of the substance, so that, if we compare the resistances of iron and platinum, the ratio of the two will be independent of the electromotor employed in the "bridge."

The effects of temporary stress on the alteration by magnetism of the resistance of an iron or nickel wire are of a somewhat similar nature to those caused by the stress on the magnetic inductive capacity of these metals, and the same may be said with regard to the effects of the permanent strains due to extension, torsion, &c. Longitudinal stress, which may be made to diminish considerably the susceptibility to alteration of resistance from magnetisation, cannot, even when carried to the extent of causing breakage, change the *nature* of the alteration.

There is apparently a close relationship between the "viscosity" of a metal and its specific electrical resistance, and it seems very probable that a full investigation of the former of these two physical properties by the method of torsional vibrations would afford valuable information respecting the latter.

* "Ann. de Chimie et de Phys." 3me serie 1844, p. 431.

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THE ELECTRICIAN.

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All communications to be addressed to 396, *Strand, London, W.C.*

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THE MORAL OF CABLE COMPETITION.

The latest experiment in Atlantic cable competition, although its course has been different from any that preceded it, has ended like them in compromise and a mutual agreement. This is not very much to be wondered at; the wonder is that any other result was ever expected. Perhaps, indeed, it never was expected, for the motives of competitive schemes such as these are unfathomable, and their aims can only be dimly conjectured. But there is one party to the transaction who always professes to be astonished, and even scandalised, at the bargain which is finally struck on these occasions by the principals. We mean the general public as represented in the newspaper press. As usual, we are now being overwhelmed with reproachful lamentations that enterprises of such pith and moment should have their currents turned awry, and lose the name of action, without the general public being consulted. So long as the current of competition runs in the direction of cheapening cable traffic no questions are asked about the interests of cable proprietors; but directly the native hue of resolution is sicklied o'er with the pale cast of thought—or, in plainer language, and to drop Shakespeare, when the competitors have had time to reflect on what they are attempting, then there comes a howl of indignation from the bystanders who expected some pickings out of the scramble.

Now, we by no means say that the proprietors of Atlantic cables, new or old, are entirely blameless; but, on the whole, we think they are greatly to be pitied. The public, on the other hand, deserve no pity whatever; and if circumstances enabled or justified the companies in running up their rates to twice or thrice their present maximum, the public would have only themselves to blame. In this matter we should be inclined to endorse the words attributed to one who has since become eminent in cable management, and who on a memorable occasion is said to have declared that he wished he had one big foot, and the public one big place to be kicked—he would certainly kick it. We cannot exactly personify the public, and, therefore, it would be unjust to impeach it on a point of ethics. But it is impossible to acquit the organs of public opinion—more or less trustworthy—of conniving at, and even of encouraging, a systematic attack upon property which in social life would be called emphatically immoral. Much of this may be set down to mere thoughtlessness, or to inveterate superstition in respect to the sanctity of unlimited competition. But by this time the lesson has been taught over and over again that no good, but a great deal of wrong, will come of reckless competition in cable laying. If the public had profited by the lessons, nothing more need have been said; but apparently they have not.

As to the so-called scandal of competing companies coming to terms, it can be answered by a single question. All other things being equal, would any customer of the telegraph lines ever dream of patronising the dearest route on the ground that it was the only route that could be worked at a profit? If not, on what grounds can he protest against the proprietors of cables combining so as to work them at a profit? He studies his pocket, they study theirs. Further, the owners of cables have the best of all right to study their own impoverished pockets. The public have no rights at all, only privileges. If submarine cables were State property there would be some reason in demanding a benevolent tariff, though it would be hard to find a tariff so low that the public would not soon consider too high. But cables are private property, they have been laid at great risk, and, as events have proved, often at considerable loss. Profit was expected, and has been well earned. But no sooner is this seen to be the case than the public encourages a competitor to divert some of the profit, in the hope of paying less for the privilege of being served. Thus far the policy of "native resolution" has succeeded. The rates have been lowered from time to time, until they could no lower go—alternated now and again by an unexpected rise, which, though perfectly equitable, was extremely vexatious. Now, after a long spell of almost unprecedented cheapness, the tariff is again to be raised to a figure which, though not full of prosperity, does not presage ruin. The public grumble; but, we repeat, the public have had by far the best of it so far; and if the companies combined—or conspired, if that word be preferred—to take it out of the public we think that the public would have no just cause for complaint.

A glance at the share list of the several Atlantic telegraph companies will bear us out in this seemingly extravagant statement. An enormous sum of money has been sunk at the bottom of the sea, some of it irretrievably lost, the rest depreciated to the extent of forty to sixty per cent. in value. What right has the public to expect this prodigious sacrifice to be made solely on its behalf? Of course, we know it is not made solely on its behalf; it is made because competitors enter upon the same line of business. But this is done with public countenance and without protest from them. Practically, therefore, the sacrifice is made to the public, if not for them; and what we say is that the public have no business, either moral or commercial, to require that such a sacrifice should be made. In the abstract we are no friends of monopolists; but if ever there was a monopoly fairly earned it is the monopoly of the sea for tele-

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graph purposes between this and America by the people who were the pioneers of that most hazardous venture. Neither are we, in the abstract, friendly to State interference, but in certain circumstances a State may justifiably step in and protect an enterprise from disaster. This it does when it subsidises one line, and declines, as it naturally would, to subsidise a second where a second is not needed. Similarly, we hold that the State would be warranted in going the length of prohibiting the landing of competitive lines when, as in the case we are now discussing, the charges over existing lines can be proved unremunerative. It is, perhaps, too late to press this argument now; but it may be worth bearing in mind when the public again show signs of demanding fresh "facilities." Meantime, it is not altogether a matter for regret that the absurdly low rates which have prevailed for some time past, and which have been favoured by a large accession of traffic, have proved once and for all a failure. They do not pay anybody but the customer; and that being so, the companies will be well advised if never again on any pretext or under any threats whatsoever do they reduce the rates below what are known to be a paying limit.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I trust Mr. Johnstone will pardon my referring him to my more extended papers—as you are good enough to find space for them in *The Electrician*—for a reply to his question as to the nature of electricity and its connection with matter and force. I would merely say now that I believe there is ample evidence to prove that electricity is not a *peculiar kind of matter*, but a peculiar *condition of matter*, which is brought about by the action of the sun upon the earth, and that *such condition is common to all matter*, although the electric force, like the magnetic, is capable of being manifested in much greater degree by some forms of matter than others.

My present paper has special reference to the influence which helical motion of one general or universal force exerts in originating those *vibrations* which are known to accompany the transmission of the imponderables.

We cannot do otherwise than acknowledge that the force of the sun first makes its presence known on the earth in the form of light.

I would premise my remarks on light, as one of the imponderables, by a brief reference to the works of that great law-giver of celestial bodies, Sir I. Newton, whose opinions as to the cause of the vibrations of light and the production of colour were based upon deductive science of the highest order, viz., experimental research. I am the more especially drawn to adopt this course from the fact that Newton believed that the trajectory from the sun was a *spiral*, and his method of explaining his "fit of easy reflection" and "fit of easy transmission," to which he attributed vibratory motions, will materially assist in conveying my views as to the mode in which *helical* motion originates the vibratory motion not only of light but of all the imponderables.

Previous, however, to entering more fully into the views of Newton, I desire to call attention to the opinions of Sir William Grove on the nature of the imponderables. In his splendid work on the correlation of the physical forces—a work which must ever remain a most valuable contribution to the literature of this vastly important field of research—after a very careful compilation of facts and application of well-known laws to existing phenomena, Sir William Grove states that there is a large amount of evidence which causes him to "*regard the imponderables as modes of motion of matter in different states of attenuation or of aggregation.*"*

I will now pass at once to a consideration of Newton's opinions upon colour and light, and, in order to do this as briefly as possible, I will quote some extracts from the life of Newton by Sir David Brewster.

Thus, at page 165, we find it stated that Newton concluded from his observations that the light which fell on the dark spaces was transmitted through the glasses without any change of colour, and that *the aerial interval of the glasses according to its various thickness is disposed in some places to reflect, and in others to transmit, the light of any colour, and in the same place to reflect one colour where it transmits another.*

From the examination of thin plates of air Newton proceeded to that of the colours of thin plates of water as exhibited in the soap bubble. Having covered the soap bubble with a glass shade, he saw its colours emerge in regular order like so many concentric rings encompassing the top of it. As the bubble grew thinner by the continual subsidence of the water the rings dilated slowly, and overspread the whole of it, descending to the bottom, where they vanished successively. When the colours had all emerged from the top there arose in the centre of the rings a small black spot, like that in the centre of the rings formerly described, dilating it to more than half an inch in breadth, till the bubble burst. "By means of these interesting observations Newton proceeds to show how the system of coloured rings exhibited by white light are produced by the superposition of the rings belonging to each separate colour in the spectrum, and he constructs a diagram explaining a method of finding the colours of which the rings are composed at any distance from their centre. He then concludes this part of his discourse with the table showing in millionths of an inch the different thicknesses of plates of air, water, and glass, when they exhibit the different colours in the seven rings or orders of colours. The thicknesses, for example, of *air, water and glass*, at which no light is reflected, or at which the black of the first ring is produced, are 2, $1\frac{1}{2}$, and $1\frac{1}{4}$ millionths of an inch respectively, and the thicknesses at the margin of the seventh ring are 84, 63, and $54\frac{1}{2}$ millionths of an inch.

"In the propositions of his 'Optics,' where he explains this theory, Newton does not attempt to assign any cause by which these fits are produced. He does not enquire whether the kind of action or disposition in which they originate 'consist in a circulating or vibrating motion of the ray, or of the medium, or of something else,' but he says that those who require an hypothesis, which, whether it be true or false, he does not consider may for the present adopt the one previously explained, in which the rays of light, by impinging on any refracting or reflecting surface, excite vibrations in the refracting or reflecting medium or substance, and that the ray is refracted or reflected according as it is in that part of the vibration which conspires with or impedes its motion. A popular idea may be formed of these fits of reflection and transmission by supposing that each particle of light, after its emission from a luminous body, revolves round an axis perpendicular to the direction of its motion, and presenting alternately to a refracting surface which it approaches an attractive and a repulsive pole, in virtue of which it will be refracted if the attractive pole is nearest the refracting surface, and reflected if the repulsive pole is nearest the surface.

"In order to explain this more clearly, let S be a ray of light which falls upon a transparent surface M N, and is transmitted by that surface. It is obvious that it must have been nearer its fit of transmission than its fit of reflection when it met the surface M N at T; but whether it was exactly in its fit of transmission or a little way from it, the theory supposes that it is put by the action of the surface in the same state as if it had begun its fit of transmission at T. Let us now suppose that its fit of reflection takes place at R, and that these fits recur at T, R′, T″, R″, &c., so that if there was a second transparent surface at T′ or T″ the ray would be transmitted, and if there was a second reflecting surface at R′ R″ it would be reflected. The spaces T T′, T′ T″, are

* "Correlation of Physical Forces," p. 112.

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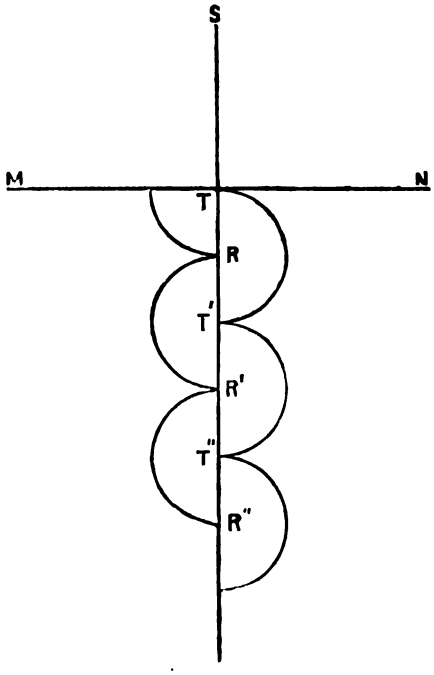
called the intervals of the fits of transmission, and the spaces R R′, R′ R″, the intervals of the fits of reflection. Now, as the spaces T T′, R R′, are equal for light of the same colour, it is obvious that the ray will be transmitted if the thickness of the body is T T′, T′ T″," &c.*

It is unnecessary for my purpose to extend the quotation; indeed, were such done, it would only be an extension of the principle which testifies throughout to the influence inequality of surface or the angle of deflection gives to the production of colour in the transmission of light.

In my last paper I endeavoured to point out that helical force pervades all forms of matter, and that the description of the helix is determined by the angle which the molecules or even atoms of matter give to momenta which are impressed upon and transmitted by them; and as we have good reasons for believing that *the same matter extends throughout interplanetary space*, and that the attenuation is only a question of degree, the same law holds good, not only with a planet and its atmosphere, but throughout the universe. The magnetic storms and other terrestrial phenomena which are coeval with disturbances in the sun's photosphere may be mentioned as some of the evidences which strongly favour this opinion.



If such a state of things exists, and it should be remembered that its existence is based upon an exceedingly close observation of magnetic phenomena in general, then the force which is given out by every portion of the mass of the earth expends itself primarily upon the atmosphere, and upon every form of matter contained in it. And by the same law by which the needle-point test magnets acquire a greater degree of inclination as they recede from the equator and approach the pole of a magnet, and the lines of magnetic force—as shown by the iron filings—increase in extension the nearer they approach the median line of the pole end, so the strands of the helical force of terrestrial magnetism will become more oblique and less perpendicular to the axis of the line of motion as the medium they are traversing becomes less dense as they recede from the earth, or, in other words, as the medium has less power of refracting the momenta.

Or, on the other hand, if we believe in the helical form of the trajectory from the sun—to which belief we are indeed driven if the sun is a mass of matter revolving upon the same principle as the earth—then the helical strands of that trajectory must become less perpendicular to the axis of motion as they recede from the mass and traverse a medium increasingly less dense; but as the medium once more increases in density as it approaches the earth, the helical strands must again become more numerous in a given length, that is, less oblique and more perpendicular to the axis of motion. At the same time they must be associated with the helical lines given out by the earth, and each trajectory will tend to work into the other, just as I have experimentally demonstrated that they do when two dissimilar magnetic poles are approached to each other, originating the phenomenon of a double helix, the strands of which, being in both cases regulated by the density of the medium which is common to both, must hold the same degree of obliquity to the axis of motion.

Now, confining our attention for the time to the simple existence of these two helices of force moving into each other from opposite directions, like the threads of a male and female screw, and the influence such momenta must exert upon the transmission of the imponderables, it is evident: 1st. That every impression made upon any medium by any one of the imponderables cannot be transmitted by such medium without being subjected to fits or periods of easy transmission which correspond with the intervals between the strands of the two helices and with Newton's "fits of easy transmission," and fits or periods of easy refraction which correspond with the lines of force and with Newton's "fits of easy reflection." 2nd. That the effects of all such impressed force must vary with the medium upon which they are impressed. If the interspaces are widely separated, and occupied by loose particles of matter, then the impressions conveyed must be proportionately feeble, for the momenta cannot be conveyed from particle to particle in any definite order. If the helices be very oblique, as they exist in rarefied media, then the propagation of impressions will be clear and distinct, and rapid in the axis of motion; but if the medium be very dense, as in an ordinary solid, then the vibrations must be transmitted with diminished rapidity in the axis of motion, and the vibrations will increase in number as the helices are more closely associated, unless there exist some molecular condition which operates to deflect or annul impressions.

If we apply this principle to the propagation of light—that is, two helices of motion, equal and opposite, gliding side by side—then light would appear to amount to *a polarisation, and not necessarily to the transmission of particles in either direction, for the momenta of the trajectories being equal and opposite, the intermediate matter must be caused to rotate upon an axis at right angles to the lines of force, and, therefore, each atom of matter between the sun and the earth is acting upon the principle of the heliostat, for by its rotation it reflects the light in the same direction, and yet remains as it were in the same place.*

This mechanical action may be easily demonstrated in the following very simple manner. Take a right or left hand helix of stout brass wire, pass into the core of the wire a wooden cylinder, over which the wire can move freely but not loosely, having separated the strands evenly, so that the interspaces may be nearly double the width of the wire, divide the helix across the centre forming two helices of equal length. Now turn each helix in the direction of its strands and they will move freely into each other. Next place some shot of as nearly the same size as the wire as can be procured between the strands, and cover with a glass tube fitting the outside of the wire pretty accurately, continue the screw motion from either end forwards or backwards in opposite directions; the shots will be seen to rotate upon an axis, as described, at right angles to the axis of motion of the strands, and to remain localised to the same spot. Consequently, so long as the trajectories are equal, the resulting phenomena must be the same, that is, in the case under consideration, a propagation of that principle which emanates from the illuminated body, viz., white polarised light, *polarised, that is, with that description of force which is characteristic of magnetic attraction*, a form of polarity which manifests its power in tending to establish an equilibrium which is atomically destroyed as soon as it is effected, yet an equilibrium which displays its power most markedly as a force in causing the lines of force projected from two opposite magnetic poles to reverse their direction and diminish the radii of the curves as the poles are brought into apposition and the mutual exercise of force

* Brewster's "Life of Sir Isaac Newton," pp. 165—168.

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increases; and an equilibrium, which, when the poles are in contact, displays no more external force than is always found at the equator of a magnet, the force from either direction being expended in lines which, from their helical character, tend to enfold each other and any intervening matter with a grip which increases as the poles are approached to each other.

This condition of the two forces is most important, and should therefore be clearly defined and as clearly understood, for I shall hope to make it evident that force acting upon such lines is not only thus intimately associated with light, but also with gravitation, and, in fact, more or less closely with every other fundamental law or principle. Unquestionably the absence of any currents of electricity from magnets, except under motion, may be traced *to the perfect equilibrium which the lines of magnetic force always display.*

We thus perceive that every ray of light consists of two helical lines of motion which are marked by density, and an interval of the same helical nature, which is characterised by comparative tenuity; and when we apply this principle of action to Sir I. Newton's theory of colour and light we find that throughout the course of a ray of light the "fit of easy reflection" corresponds with the two lines of force, and the "fit of easy transmission" with the interval or intervals between the lines; and, further, that when light is passing through any diaphonous medium *the luminosity is capable of being transmitted as ordinary light, provided the relations between the lines of force and the intermediate space or spaces be not disturbed; but when light falls upon any surface which mechanically discomposes balance of power by inequality of the surface of the refracting medium, then polarisation occurs in another direction* with the evolution of all those phenomena which *depend, as Newton and others have shown, upon surface inequality.*

The somewhat recent researches of M. Jamin upon the colour of metals bears powerful testimony to the above deductions being correct as regards the laws of light; for he proved that the various colours were due to the particular mode in which each metal polarised light; and if we refer this principle of polarisation to the particular mode in which matter in general, and the metals in particular, refract force owing to constitutional differences of a molecular or atomic nature, we perceive that the principle is as universal as I have attempted to describe it.

It will, therefore, be evident that this combined force from the sun and force from the earth converges to or radiates from the earth in lines of equal inclination, being, as regards the general line of motion in the plane of the ecliptic, nearly vertical, that is, nearly at right angles to the motion of the earth, but taking every degree of inclination as they pass away from the ecliptic and approach the magnetic poles; whilst, as the lines of helical motion are ever presenting to the axis of general motion a point which differs from contiguous points in its inclination to the axis of general motion, analogous to the inclination of the points on the surface to the centre of a sphere, so it is impossible that any momenta can be applied to these trajectories from the sun and earth without the production of vibrations, which must be transmitted in every direction, and which must correspond in rapidity with the continuity and velocity of the impressed force, for it is difficult to imagine that any two momenta, however closely associated, can be made upon the same point of the revolving helical lines.

We cannot fail to observe also that these vibrations must be more distinct in proportion as their motion is freely communicated, and that when such vibrations are transmitted through matter in a minute state of subdivision, the particles of which have freedom of motion, the vibrations must be reduced to an extent proportional to the momenta such particles receive and irregularly distribute.

Upon this principle we find that every form of matter which has an existence upon the earth and throughout interplanetary space is subjected to the laws of action and reaction, or stress, as it is now termed. That this stress, as far as the planetary system is concerned, may be said to commence when the trajectory is emitted by the sun, that it is continued through interplanetary space to the earth, more especially in the line of the ecliptic, and thence, modified in its direction by the motion of the earth, to the magnetic poles; and during the whole of such course, as stress, it is ever acting upon the same principle as I have described already as the method by which light is propagated from the sun to the earth, and polarised with that description of polarity characteristic of magnetic attraction, which manifests its power in tending to establish an equilibrium which is atomically destroyed as soon as it is effected.

It is as impossible to conceive of space without matter as matter without force under such a state of things, for every celestial body by its motion propagates force, and every manifestation of force is bound to be associated more or less intimately with matter. Nevertheless the degree of force is not necessarily regulated by the matter, as I have shown, by its passage through the so-called vacuum tubes, but is capable of being invisibly transmitted through a transparent medium. It makes its presence known as force by coming in contact with a visible solid and imparting motion to it, as shown by the motion of magnetic bodies, or even by diamagnetic forms of matter when they are suspended in the field of an electro-magnet, the comparative slight motion of the latter being due to the facility with which they, as compared with magnetic bodies, transmit force.

There is, consequently, no ground for assuming that there is some *special* form of matter which pervades all other matter, and which, to the exclusion of all other matter, has a separate entity, and which may be properly designated as electric matter. It appears to me that we might as well speak of magnetic matter, or gravitation matter, apart from the matter upon which the force is operating to give origin to the phenomena of magnetism or of gravitation. Doubtless the condition of matter and force which I have attempted to define is the same matter as that to which Newton gave the name of ether, the prevalence of which was essential to the existence of the laws promulgated in the "Principia," and so far as the rotation of the ray of light is concerned the points I advocate appear to be established by the influence of electro-magnetism on a line of light, for it is well known that the light is rotated to the right or left as the direction of the electric current varies in the same way, or the nature of the matter is changed.

Sir William Grove takes a similar view, for he says, "There appears to be no reason why the atmosphere of the different planets should not be with reference to each other in a state of equilibrium. Ether, which term we may apply to the highly attenuated matter existing in the interplanetary spaces, being an expansion of some or all of these atmospheres, or of the more volatile portions of them, would thus furnish matter for the transmission of the modes of motion which we call light, heat, &c.; and possibly minute portions of these atmospheres may, by gradual accretions and substractions pass from planet to planet, forming a connecting link of material communication between the distant monads of the universe."*

Now, if we accord to matter the property of being combined into masses as in the planets, or of being diffused in a highly attenuated form, such as that in which it is supposed to exist in interplanetary space, *then there must reside in the matter some force by which mass accumulation is effected, the the removal of which must permit the expansion of the atoms and of the mass as a whole.* Again, this power must reside in the elementary atoms, as well as in the largest mass, for a mass is but an aggregation of atoms; and when we further recognise the fact, to which I have already referred, that this property cannot be dissociated with the mode in which matter transmits force, then we are bound to admit that the atoms have been formed subject to a force which has compressed the atoms in a definite direction, and this direction must accord with the line of the greatest density.

If we next direct our attention to crystallisation, that process in which invisible atoms of matter are collected, definitely arranged, and converted into solid masses of considerable bulk by an invisible force, then we find the same process taking place under precisely the same manifestation

* "Correlation of Physical Forces," page 122.

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of power as I have already briefly described. In my present paper I cannot do more than call attention to the investigations of Plücker and Faraday on this subject, stating that Plükcer inferred from his experiments that there exists a relation between the *forms* of the ultimate particles of matter, and the magnetic forces, and that Faraday regarded this as an *optic axis* force exerted in an *equatorial direction*. We, therefore, perceive that from this cause, when matter is exposed to magnetic force, it is bound to move in a direction corresponding with that in which its atoms have been primarily arranged, even although stress be applied in the form of an invisible force.

In my next paper I shall hope to define clearly the intimate connection which exists between these manifestations of force in the atoms of matter and the force of gravitation.—Yours, &c., R. D. SHETTLE, M.D.

London-street, Reading.

THE SELLON SECONDARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg you to be good enough to insert in your next issue the following letter, which I have addressed to Mr. Sellon.—Yours, &c., S. PHILIPPART,

President and Manager of the Company.

Société Anonyme La Force et la Lumière, Avenue de l'Opéra No. 5, Paris, April 11, 1882.

TRANSLATION.

Mr. Sellon, vice-chairman of the Anglo-American Brush Light Company (Limited), London.

SIR: I have just read in *The Electrician* an account of your speech at the dinner given by your company at the Crystal Palace last week.

I am well aware that one must make a certain allowance for statements that may be made upon such an occasion, and I only wish for the present to recall the following sentences which you have uttered among many others:—

"*I state frankly and openly that if it can be justly proved that our patents are in any point tributary to the Faure, we most willingly recognise the fact; I have too great a regard for the rights of inventors not to be the first to protect them, whether or not to my disadvantage.*"

These words, at least, are those of a gentleman, and I would be very pleased to see none but these amongst those you are reported as having uttered, and I would willingly accept the offer to submit the question to a jury under the following conditions:—

The jury should be composed of three Englishmen, two Frenchmen, one German, and one Austrian, whom we shall choose by mutual consent among the most competent and honourable men of the present day.

I engage to produce before such a jury the proofs of the following facts:—

1st. That not one of Volckmar's patents is valid, and that not a single one belongs to him as an inventor.

2nd. That the accusations brought by Faure against Volckmar in the action to annul the patent are most scrupulously exact.

3rd. That the inventions which you believe yourself to have made in the forms of metal plates were in use for a long time before you took out a patent for them.

You may dispute my proofs, but the jury will decide.

It is well understood that my proposition is made for the purpose of showing your good faith, but it will not in any way stop the actions which are at present going on.

You certainly cannot object to my publishing this letter, as well as the answer which you may think proper to send me.

Awaiting your reply, I remain, Sir, yours truly,

(Signed) SIMON PHILIPPART.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read of the proceedings anent this battery on Tuesday, the 4th instant, at the Crystal Palace, and I beg you will allow me space in your valuable paper to answer some of the statements made by two of the speakers. I will be as brief as possible, and confine myself to absolute facts.

I will first recall the two points which form the apparently solid basis of Mr. Sellon's theory as to the reality of the patent rights of the "Electrical Power Storage Company." These are, first, Mr. Swan's May patent and Mr. Sellon's September and subsequent patents purporting to cover forms of plates, or practically perforated plates. 2ndly. The well-known fact that peroxide of lead has been known as a depolariser as long ago as 1844.

This is my answer, viz.: I am able to prove that, being in my office, 446, Strand, in the middle of August last, I gave distinct orders, verbally and by letter, to the manufacturers of my batteries in France and in Belgium that all plates ought to be without exception perforated.

My French patent is dated 20th October, 1880. In December, 1880, I was in possession of a French patent the principal claim of which is the application of perforated plates. According to the French law I might have embodied this as an addition to my first patent.

On the 9th February, 1881, I again filed in France a patent specification, No. 141,057, in which I distinctly mention *suitable metallic wire gauze* as a substitute for felt for holding the lead material against my plates. Thus you will see that a long time previous to any date mentioned by Mr. Sellon I was in possession of all the elements of what he led his hearers to believe was his or Swan's battery. In February of last year I was manufacturing elements for secondary batteries by retaining lead material or oxides in between two perforated coverings; this mode of manufacture I am carrying on, and all these facts were well known in England by men of standing.

Respecting the mention that peroxide of lead has been used as a depolariser in primary batteries, it might as well have been mentioned that it has also been used as a paint.

Secondary batteries of the form in question consist of *two* electrodes, around which is piled the peroxide of lead or any lead material capable of answering the purpose, and these two plates form part of an electrical arrangement in which the current is alternatively in either direction.

Three more dates, and my sincere thanks to you, sir, for this mention will terminate what I have to say for the present.

I first began the proceedings before the French courts against Mr. Volckmar on the 28th of March last, and the hearing of the case was fixed for the 1st of April. I was duly met at the court by Mr. Volckmar in the person of Maitre Cortot, Avoué, 88, Rue de la Victoire, duly constituted for this special purpose on the 31st of March.

Is it not passing strange that Mr. Volckmar, on Tuesday, 4th of April, should, by the mouth of Mr. Courtney, have emphatically denied having heard anything about these proceedings?—Yours, &c., C. A. FAURE.

22, Boulevard Voltaire, Paris, 11th April, 1882.

THE COST OF ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The thanks of all who are interested in electric lighting are due to you for your table of the cost of working; and with regard to your article on the cost of the Hammond system I should feel obliged if you will explain why £1,000 is taken as the cost of the necessary plant for 32 Brush lights, as by Hammond and Co.'s price list the estimate for 16 lights, not including cables and carriage, is £766 15s., or £1,533 10s. for 32 lights, which, added to the cost of the necessary motive power—as quoted by yourself, £300—will make over £1,833 10s. This would increase the cost under heads of maintenance and interest by £200, and would make the hourly cost of each light $5\frac{3}{4}$d.; while on page 9 of the list above referred to the total cost is given as about $1\frac{1}{2}$d. per hour per light of 2,000 nominal candle-power; and on page 13 the total hourly cost at the South Kensington Museum of sixteen Brush lights is shown to be 3s. 10d. per hour, or about 3d. per hour per light.

With reference to the candle-power, which is given as being 2,000 candles, and always referred to as of this intensity, there is a note on page 14 of the same price list that the candle-power of light is measured with the carbons in the best position, and may be considered the maximum light they

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will yield, and again, in the price list published by the British Electric Light Company, there is a note stating that the actual illuminating power may be taken as about *one third* the *nominal* candle-power, which fact should be borne in mind in making comparisons.

I hope you will be able to give the same details in the other systems of electric lighting, as they will be watched with great interest, more especially as the results obtained by an independent expert do not always agree with the statements of the companies themselves. Apologising for troubling you.—Yours, &c., FRANCIS CHERRY.

Wardrobe-chambers, Doctors Commons, April 5.

ELECTRICAL REPULSION.

BY J. T. SPRAGUE.

"Two bodies similarly electrified repel each other."
"Similar magnetic poles repel each other."

Are these statements, made in every text-book, true? As phenomena, or apparent facts, they are true, because, as a matter of fact, the bodies in these circumstances do recede from each other. But is the scientific explanation true? Do they *repel* each other? The question is part of a wider one. We can find its answer only in the answer to the question, Does a repulsive force exist in nature?

The exact science of to-day has been evolved by a gradual process of development from the "science falsely so called" of old times, which science was, in fact, nothing but the "vain babblings and oppositions" of metaphysics, the endeavour to explain facts by *à priori* notions. But the trammels of the past are not readily thrown off, and, strange as it may seem, it is a fact that the exact mathematician tends to a marvellous approximation to the vague metaphysician—explainable, however, by his practice of converting facts into abstract symbols, and too often of converting a mere arithmetical process into a theory. Then, in the days when the simpler electrical facts were discovered, the evolution of science was in its first stages. No man hesitated to create any "force" or "fluid" which would help him to an explanation of what he saw; and, as a consequence, science has had to kill off quite a number of these Frankensteins inflicted upon it by early discoverers. The magnetic fluids have been comfortably buried long ago, the electric fluids yet retain a feeble lingering vitality, and repulsion is still an active giant whose aid has quite recently been invoked to conquer the undiscovered secrets of comets' tails.

I do not know anything about comets' tails (does any one?), and therefore to deal with them would be to commit the very error I am pointing out, viz., the attempt to explain apparent facts by some *à priori* theory before we have ascertained the nature and order of the facts themselves. But there are many cases of apparent repulsion into which we can safely inquire in order to discover whether a "repulsive force" exists in nature or whether it is a mere artificial creation, an *à priori* antithesis to attraction. Metaphysics and mathematics alike would have a natural tendency to believe in such an existence as the opposition of attraction and repulsion, the centripetal and centrifugal forces. Let us, then, examine various cases in which an apparent repulsion occurs.

When a gun is charged with powder and ball the explosion of the powder confers motion in opposite directions upon the gun and the ball. This used to be explained by a repulsive force—that is to say, it is due to the sudden expansion of the gases set free by the chemical action, and in order to explain this expansion it was believed that while the solid state was due to certain *attractive* forces possessed by the atoms, resulting in cohesion, in the gaseous state these atoms possessed a *repulsive* force causing them to increase their distances. We have here a step in the evolution of science, for the idea of a gaseous repulsive force is utterly abandoned and superseded by the mechanical theory of gases; that is to say, in this case *the repellent action is seen to be a consequence of atomic motions*, or, in other words, not of a *repulsive force possessed by matter*, but of *energy charged upon matter*.

It may be here remarked that in a similar manner *heat* has been struck out of the category of repulsive *forces*; its expansive actions are now universally recognised as simple consequences of increased molecular and atomic motions due to energy charged upon matter.

When a ball is struck by a cricket bat a very evident *repellent action* is developed, but probably this phenomenon was never explained as resulting from a *repulsive force* existing in the bat. Even before the doctrine of energy came into existence this motion was recognised as resulting from the energy (though probably miscalled the force) of the batsman.

If we take an empty bladder, and lay it upon the ground, it lies there, because there is an *attraction* between its particles and those of the earth. If we fill it with carbonic acid gas this attraction still exists. If we fill it with hydrogen gas this attraction ceases, and the bladder rises in the air. Has our bladder or its contents become possessed of a *repulsive force* as regards the earth? That has often enough been seriously maintained, though every scientific man now would ridicule the idea. But why does the hydrogen rise and carry the bladder with it? Let us hang a 1lb. weight to a cord over a pulley, attaching a 10lb. weight to the other end of the cord but supporting it by another attachment. The pound weight lies on the earth by virtue of the mutual attractions of gravitation. Cut the attachment of the other weight, and our pound weight is at once repelled from the earth, drawn away from it, that is, by the superior attraction of the ten pound weight. But this is precisely what happens to our bladder; as an *apparent* fact, it *rises* as though repelled; as a *scientific* fact, an equal bulk of heavier air *descends*. The rise of the bladder is not, then, the primary fact, though it is what occurs to our observation, it is simply a result of an invisible fact occurring in consequence of an attraction, not of a repulsion.

Here we are brought in face of the great question, "What is gravitation?" and it seems not unlikely that when that question is answered the force of attraction will disappear as well as that of repulsion, and it will be found that all these forces are but expressions for actions of energy. Meanwhile, we must be content with the expression of the fact that all matter does attract all other matter, but why or how we do not know. But existing knowledge suffices to teach us that the ordinary way of regarding the matter is very imperfect. It is wrong to regard any single thing or substance as isolated, or having an independent existence. A falling body and the earth do not attract each other as separate bodies, but because each forms part of a "field of force" which unites them in one. No single atom of matter exists by or for itself, or is capable of a separate existence; it forms part of one great whole. Each atom is in one sense the centre of the universe for itself, acting on and being acted on by the whole universe of being, but by the law of action and of circles, influence being in the ratio of the squares of the distance, its principal relation is with its immediate surroundings. But in another sense each atom is but a portion of the universal and of the local fields of force influencing it, and obeys the influence of the sum of the forces acting upon it. It is this growing idea of fields of force (or, possibly even more correctly, fields of energy merely expressed as forces) which is the characteristic of modern physics, and which is steadily sweeping away the old artificial ideas of separate forces as actual entities, fluids, and so on.

Now to return to our bladder of hydrogen. It rises, not because of any force of repulsion as opposed to attraction, or of levitation as opposed to gravitation, but because it forms part of a field of force constituted of the separate forces of all surrounding bodies, the action of which is summed up in the expressions of the force of gravity, and the relative specific gravities of hydrogen and air. That is to say, it takes that position in its field of force to which it is impelled by the sum of all the attractions exerted by itself and all the other constituents of the field of force in which it exists with capacity of motion. If its motion were limited (as by a string) the sum of those forces would manifest itself as a static strain or tension, just as in the case of solids it is manifested by the static strain or pressure of weight.

We now come to the more occult effects of magnetism. Here we certainly have a repellent action, apparent at all events. But the question is, not the fact, but the cause of the fact. When a south magnetic pole is presented to another south pole it evidently pushes it away from it as effectually as though a solid bar connected them. But when we closely examine the fact we find that it is not a direct push, but an endeavour to turn the magnet round on its axis, and when that cannot be effected we may see that it is still an effort of a similar character which causes the magnets to recede from each other. Before examining the facts, let us consider, first, "What is a magnet?" It is usually a piece of steel, but this is not the *essence* of the magnet; to use the metaphysical terms, the solid apparent magnet is the *accident*. The *substance* of a magnet is a *field of force*; the space surrounding the steel is as essentially a portion of the magnet as a bar of steel. In fact, we can dispense with the bar of steel, which is to all appearance the source and centre of the field of force; but the field of force exists wherever a magnet exists. A simple circular electric current is as true and perfect a magnet as a bar of steel, but the conditions of the magnet in that case are reversed. The field of force exists, and is exactly the same as that due to a magnetised bar of steel, but it has no visible centre or material poles,

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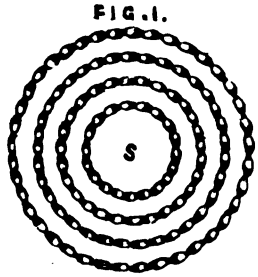
though these exist. Such circular currents have all the properties of attraction and repulsion which are presented by magnets. Nay, it has recently been shown that mere physical currents produced in water will set up just such phenomena of attraction and repulsion, and in this case we have visibly before us the fields of force created directly by the charging of energy upon the molecules of water set in motion mechanically. We have also the fact that an electric current can exist nowhere without setting up fields of force of two natures—first, the static electric charge; second, the magnetic field. These absorb no energy after once they are set up, and give up the energy of their creation when the current ceases; also the entrance of a conductor into a magnetic field sets up in like manner a momentary electric current equivalent to the mechanical resistance offered to the entrance of the conductor into the field, proving that some molecular change occurs in the conductor, which change apparently consists in its molecules being put into that condition which enables them to form part of the field. All these facts show us that electricity is essentially a dynamic force or condition, while magnetism is essentially a static force or condition linked to electricity, and exerted at right angles to the electric action.

We can now form a mental picture of the magnetic field of force. Ampère's theory would show us all the molecules forming it as rotating in their axes in parallel order, these axes forming the polar direction of the magnetic system. But Ampère's theory has this fatal defect, that if the assumed molecular currents forming an inherent part of the constitution of matter did really exist, they must by the fundamental laws of electric currents always arrange themselves in this order. We should require a force to de-magnetise instead of to magnetise matter. But if we recognise magnetism as a static condition of the molecules, we may picture the field as composed

FIG. 1.



of molecules arranged in circles under a static strain of the electric nature, exerting magnetism at right angles to the plane of the circles. In fact, a magnetic field on this view exactly resembles a solenoid, or an electro-magnetic coil, which we know perfectly is a true magnet. Fig. 1 conveys the idea of such a field, of which it is a section in the plane of the circles, and we may conceive each circle as a kind of spiral spring in which energy is stored up ready to be exerted as magnetic actions; the energy in each portion varying according to the universal radiant law in the ratio of the square of its distance from the centre.

STORAGE OF ELECTRICITY.

CAMILLE FAURE *versus* E. VOLCKMAR.

The following refers to the legal proceedings instituted in France in connection with secondary batteries:—

TRANSLATION.

To the President of the Civil Tribunal of First Instance of the Seine.

Mr. Camille Faure, Electrical Engineer, residing at 22, Boulevard Voltaire, Paris, by Mr. Rousseau, his solicitor,

Has the honour to lay before you,

That he has taken out in France two patents for inventions, the first on the 20th of October, 1880, under the No. 139,258, to which are attached two certificates of addition, dated the 16th January and 19th October, 1881, for different improvements relative to galvanic batteries known as polarisation batteries, which are capable of storing up electric energy derived from different sources, and of giving it back when and where required, and for the application of perfected batteries to locomotion. The second patent, dated 9th February, 1881, No. 141,057, to which is added an additional certificate of the 15th March, 1881, for the manufacture of couples of secondary galvanic batteries.

That he has entrusted the industrial working out of these patents, under his technical superintendence, to the Company "La Force et la Lumière."

That the Company in question was under the direction of Mr. Philippart, senior, and had as managing director Mr. Simon Philippart, his son.

That Mr. Philippart, junior, during his absence from Paris in the course of the summer of 1881, delegated to a Mr. Ernest Volckmar the management which had been entrusted to him.

That, thanks to this position, Mr. Volckmar had free access to the workshops of the Company, and every facility for learning the processes and secrets of the manufacture and carrying out the discoveries patented by Mr. Faure.

That he was not long before he grievously abused the confidence which had been placed in him, that, in fact, he used his influence to lead astray from his duties Mr. Gustave Philippart, another son, who was at that time a minor, under age, and succeeded in inducing this inexperienced young man to cheat his father and the company in whose service he was. That he even became associated with the young Mr. Gustave Philippart, and that since then the two have together used all their endeavours to corrupt the workmen of La Force et la Lumière Company, and to compete treacherously against their former masters.

That they went so far to give their manœuvres an appearance of right as to take out, in the name of Mr. Volckmar, a patent of invention dated 8th October, 1881, and an additional certificate on the 7th November, 1881.

That this patent and certificate of addition constitute plainly and indisputably an infringement on the processes patented long before, on behalf of Mr. Faure.

That these are to the petitioner a great cause of trouble and injury, and hinder him from duly benefiting by his invention.

That it is of pressing importance to have the patents obtained by Volckmar in defiance of the petitioner's incontestable rights annulled.

That the steps taken by Volckmar under the said circumstances have had the effect, as was premeditated, of injuring the plaintiff.

That Volckmar is bound to thoroughly make amends for this.

That there is urgency.

For this reason he begs that it may please you, "The President," to sanction his summoning at short notice Mr. Volckmar before the Civil Tribunal of the Seine.

To hear it stated that the patent taken out by Mr. Ernest Volckmar on the 8th October, 1881, No. 145,218, together with the additional certificate of 7th November, 1881, is null and void.

To hear the Public Prosecutor demand its absolute nullity.

To hear himself, in addition, condemned in 100,000 francs damages for the injury done.

(Signed) A. ROUSSEAU, Solicitor.

We, the President, considering the above petition and the documents in support thereof, authorise the petitioner to summons Mr. Volckmar at the short notice of three clear days before the Civil Tribunal of the Seine, with the object of the above petition, and this through Gautier the crier of the Court, whom we appoint so to do.

Given at the Palais de Justice, at Paris, the 28th March, 1882.

(Signed) FLOGNY,
President of the Civil Tribunal of the Seine.

Registered at Paris, 28th March, 1882.

(Signed) DELZANGLES, Registrar.

ELECTRIC LIGHTING AND THE TRANSMISSION OF POWER.

This was the subject of a lecture, an abstract of which we give below, delivered by Mr. A. Jamieson, in the Argyllshire Hall at Oban, on Thursday week, on the occasion of the opening of an exhibition of electrical instruments and appliances, promoted by the local Scientific and Literary Society. The exhibits included Swan, Lane-Fox, and Brush lamps, some of which were supplied with current from a Brush dynamo driven by the engine of a printing press near the hall. The same dynamo also supplied the necessary current for actuating a saw, turning lathe, and sewing machine. There were also on exhibition one of Clark's magneto-electric machines, King's electrical steering apparatus, specimens of cables laid in South American waters by Messrs. Siemens Brothers (in the laying of which Mr. Jamieson had assisted), telephones, telegraph instruments in operation (shown by Mr. McLean, Postmaster of Oban), burglar and fire alarms, &c. The lecture was illustrated by large diagrams giving sections of the Gramme dynamo machine, Brush lamp, &c.

Mr. Jamieson began by alluding to the great hold that electricity and its applications had taken upon the public mind within the last year or so. He then traced the history of electrical machines, from the first discovery by Faraday, in 1832, of the principle of magneto-electric induction, up to the present time, describing, by the aid of diagrams, some of the principal machines now in use. Having alluded in some detail to the Brush system of electric lighting, and shown the Swan and Lane-Fox lamps in action, Mr. Jamieson passed on to the consideration of electricity as a power-transmitting agent. "If," he said, "we take this horse shoe magnet, within which a coil of wire is suspended free to revolve on an axis, it will be seen that immediately upon causing a current from this battery to flow through the wire of the coil, the coil itself revolves with great velocity, actually rotating two thousand times in a minute, in virtue of the attraction and repulsion which together act as a couple or double lever upon the coil. Here we have a certain quantity of zinc consumed, generating a certain amount of electricity, capable of actually doing work." He then showed a machine for steering vessels by electricity, which is the invention of Mr. King, late electrician-in-chief to the Western and Brazilian Submarine Telegraph Company. This machine was used to steer a large steamer of over 1,000 tons sailing from the Clyde. "In this you have one of the latest and most striking adaptations of the conversion of electric energy into useful work. We will now take advantage of the electricity generated by the Brush machine in the *Oban Times* office. The electricity is conveyed along a strand of three stout wove wires, fixed to insulators upon wooden poles, and brought in through the roof by this wire to the small Gramme motor. Upon completing the circuit you will notice that the coil revolves with great velocity, driving, by means of pulleys and belts, the saws and lathe, as well as the sewing machine, by means of this small French motor kindly lent by Messrs. Mason Brothers, Hope-street, Glasgow. What I have now shown you is exactly what Dr. Siemens and Sir William Thomson propose should be carried out with the Falls of Niagara, or nearer our own home with the Falls of Clyde. It is only necessary to place water wheels or turbines at these various places, avail ourselves of the force of gravity to turn electrical machines, and transmit the electrical energy thus obtained to corresponding electrical machines situated in distant centres of industry, obtaining thereby a considerable percentage of the force of the waterfall in useful work. Or you here in Oban might easily take advantage of Connel

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Falls to light your town and work your churns, and I shall be very glad to show you how." Mr. Jamieson concluded by thanking the Brush Company and their representative, Mr. Partridge, for placing at his disposal their machine and lamps.

The next evening Mr. Jamieson gave a description of the Joel lamp, and the telephones exhibited were explained and put into operation.

EDISON'S SYSTEM OF INCANDESCENT LIGHTING.

On Tuesday night an exhibition of Edison's system of lighting by incandescence was given at the offices of the Edison Electric Light Company, No. 57, Holborn-viaduct, E.C. The Company have now completed the fixing of their lamps on the Viaduct, and in the various shops, &c., in the immediate neighbourhood, and although these lights have been running for the last night or so, the proceedings of Tuesday night may be said to have been the opening ceremony.

Those who had been invited for the occasion were received by Mr. Johnson, manager of the company, who, prior to explaining the different varieties of lamp, conductors, meters, &c., proceeded to say a few words on Mr. Edison and his inventions.

Mr. Johnson said that Edison had recognised from the very first that the problem of electric lighting could only be solved when the public could be supplied with electricity through a meter, at the same price as gas. This could not be done by placing a steam engine and dynamo in every house, but by having a large central generating station, from which the electricity could be conveyed by conductors to the houses where it was required, and there used as wanted, a meter registering the exact quantity consumed, in precisely the same way as was at present done by gas meters. He alluded to the innocent remark made by Mr. Edison to an American interviewer, and the consequent misunderstandings that had arisen as to what Mr. Edison was really doing. After this remark the world did nothing but talk of Mr. Edison, and he became famous. Soon after, as the expected light did not come forth, the world began to sneer at him, and for two years he was almost lost to sight. All this time he was perfecting his system, with the results that would presently be shown, and which London had the honour of seeing practically in operation for the first time. As to the question of cost, Edison said that electricity was cheaper than gas, because he had satisfied himself that he could get more light from one pound of coal by using electricity than he could by using gas. The question was, could electricity be distributed through the streets at a low enough cost to enable it to compete with gas? Now, that was a question of the cost of the copper necessary for the conductors, and the cost of the copper for the conductors hinged upon another question, viz.: How economical was a lamp in converting electricity into light? Now, that was determined by the resistance of the carbon; and this, therefore, determined the size of the conductors, and the cost of them. Edison could compete with gas when lighting an area of a mile square, but not over that limit, on account of the cost of the copper conductors. The manufacture of electricity on a large scale could alone determine the unit of the main plant in the statement of cost. He would show them below a dynamo-machine maintaining 1,000 lamps at 16 candle-power each, reaching from Hatton-garden to the Old Bailey. The whole details of the cost of this installation would be taken into account in estimating the relative cost of lighting by electricity and by gas, and such well-known electricians as Dr. Hopkinson and Dr. Fleming would carry out the calculations. In answer to a suggestion that he had not taken into account the fact that gas companies, having a practical monopoly, could charge a high price, and that this price was much above the actual cost of the gas, Mr. Johnson said that Edison had based his estimate of the relative cost of the two means of lighting upon the cost price, and not the actual price charged to consumers. With reference to the residual products which went to swell the gas companies' dividends, he would say that the Edison Company supplied electricity not for lighting only but for the production of power also, and this latter he looked upon as quite equivalent to the residuals of the gas companies. He might say that if people would utilise the electricity for power they could give it away for lighting purposes. Referring to Mr. Edison again, he said that it was this aspect of the question that he was working out during his disappearance before alluded to. People then said that the whole thing was a fraud; however, he reappeared again, and others with him. During his disappearance he had worked the problem out, and found that the products of electricity could be sold so as to enable it to compete with gas. It was a well-known fact that as you increased your output you decreased the cost of production, and, therefore, as you decreased the output of gas you increased its cost. As to the question of danger from fire, he (Mr. Johnson) about a year ago wrote to the *New York Tribune*, stating that if the electric light installations were continued as they had then been established, there would be numerous fires. This happened as he had predicted, and the New York Board of Underwriters had to stop the putting in of electric light plant until they could ascertain what were the necessary conditions of safety. They went to Edison, and he turned them over to him, Mr. Johnson. He showed them the plug, which was fitted in every room lit by the Edison system, and which acted as a safety plug. This plug stepped into the path of the current as it went to each lamp, and acted in a precisely analogous manner to the fusible plug in a boiler, as he would show them presently. He then alluded to the recent rise in their rates that had been made by some of the insurance companies on the exhibits at the Crystal Palace. They, the Edison Company, had heard nothing of it, except through the newspapers, so they took the initiative, and went to the insurance companies; they then found that the companies had let them alone. This was a sufficient comment on the safety of their system. He might add, however, that the insurance on their present building in Holborn-viaduct was at the lowest rate that was charged on any similar class of building in London. It might now be asked who were they? In reply he would say that originally they had come over to make a practical demonstration of their system. Then came the Crystal Palace Exhibition, to which they at once turned their attention, and he thought it would be admitted that they had not done badly there. Then came the question of the formation of a company to take over Edison's patents—there were only forty-two of them—to ascertain their validity, and work them. He thought that the board of that company was a sufficient guarantee as to its status. Then, as regards the electrical side of the question, they had retained the services of two such able electricians as Dr. Hopkinson and Dr. Fleming. Being asked as to how far the heat from the Edison lamp would affect the temperature of a room, Mr. Johnson replied that perhaps as good an answer as any he could give would be to give the average temperatures recorded in Dr. Parker's Temple on the Viaduct during the last four Sundays, lighted as it was by 170 Edison lamps. The figures had been furnished to him by the janitor of the Temple, and were as follow:—Average temperature when lighted by gas at this time of year, over 80deg.; average temperature for last four Sundays when lighted by Edison lamps, 58, 61, 65, and 52deg. In answer to a further question as to the danger to life accruing from the use of the electric current, Mr. Johnson stated that, according to their system, there was absolutely no danger at all. The danger arose from the manner in which some engineers connected up the lamps. Connecting up in series, as had been done by some, was not the proper way for incandescent lamps; it was like sticking up a row of targets one behind the other, and then expecting your projectile to go through the last as fast as through the first. This was an impossibility. But if the lamps were connected up in multiple arc, as in the Edison system, the current was divided equally between all the lamps. (Mr. Johnson here explained the multiple arc system.) When they were down in the engine room he would show them how, when the dynamo was supplying a current sufficient to keep 1,000 lamps at 16 candle-power, he would lay hold of the conductors leading from that machine, and pass the whole of this enormous current through his body without receiving the slightest injury. Perhaps that would impress them with the absolute safety of their system. He then invited those present to accompany him down stairs to inspect the machines and lamps, first cautioning them to leave their watches upstairs, to avoid their possible magnetisation and consequent stoppage when in the proximity of the dynamos.

The way in which the lamps on the Viaduct were controlled from the central office was then explained, the visitors adjourning to the street, whilst the lamps in the various circuits were alternately extinguished and lighted again, by turning the different switches in the office. After practically illustrating the action of the fusible plug, and showing the meters used, Mr. Johnson led the way to the engine room, where the two large dynamos are placed, one only being required to work all the lamps at present in use, the other being kept in readiness in case of a breakdown. Mr. Johnson, according to promise, passed all the current from one of the machines through his body, and seemed none the worse for it. He then illustrated the rapidity with which, in case one machine broke down, the other could be got to work. Before leaving the engine room Mr. Johnson paid a high compliment to Mr. Hammer, his assistant, to whose energy, he said, he had been greatly indebted. The big dynamo and engine were illustrated and described in a recent issue, and it is not, therefore, necessary to refer to it further here.

The Edison lamps are now in daily use on the Viaduct, in a great majority of the shops on the Viaduct, in Dr. Parker's City Temple, and Spiers and Pond's Viaduct Hotel, and the light given by them is most satisfactory. We shall hope to refer to the details of the system at greater length in a future issue.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices April 12.		Business Done Week Ending April 12. Highest.		Lowest	
Anglo-American	52½	53	52½		51¾	
Do. Preferred	82,	83	82¾		81¾	
Do. Deferred	23½,	24	24¼		22¾	
Brazil Submarine	10⅞,	11⅛	11⅛		10 15-16	
Cuba	8¼,	8⅜	8⅜		8¼	
Do. Preference	15½,	16½	—		—	
Direct Spanish	6,	6½	6½		6½	
Do. Preference	15½,	16½	16 1-16		16	
Direct United States Cable	11⅛,	11⅜	11⅜		10⅞	
Eastern Telegraph	10,	10⅛	10 3-16		10 1-16	
Do. 6 per Cent. Preference	12½,	13⅛	13		12 15-16	
Do. 5 per Cent. Debentures, 1899	102,	107	—		—	
Eastern Extension	11⅛,	11⅛	11⅛		11⅛	
German Union	9½	10	—		—	
Globe Telegraph and Trust Company	6¼,	6½	6½		6 5-16	
Do. Preference	12½,	12⅝	12⅝		12½	
Great Northern	13,	13⅛	13⅛		13⅛	
Indo-European	29,	30	29⅝		29⅝	
Mediterranean Extension	1⅝,	2⅛	—		—	
Do. Preference	8½,	9	—		—	
Reuter's	13⅛,	14	14		13⅛	
Submarine	260,	270	—		—	
West India and Panama	1⅞,	2⅛	2 1-16		2	
Do. 1st Preference	8⅛,	9	9		8 13-16	
Western Brazilian	8⅛,	8⅜	8 5-16		8 5-16	
West. Union 7 per Cent. 1st Mortgage	124,	129	—		—	
Do. 6 per Cent. Sterling Bonds	102,	105	—		—	

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1¼	1 9-16		1⅛	
Oriental	⅛,	¼	—		—	
United Telephone	13⅛,	13⅜	13 7-16		13 5-16	

ELECTRIC LIGHT.

Eastern Electric Light and Power	⅛,	¼	--		—	
Electric Light and Power	⅛,	⅜	13-16		11-16	
Anglo-American Brush	11,	11¼	11¼		10 13-16	

TRAFFIC RECEIPTS FOR MARCH, 1882.

Companies.	March, 1882.	March, 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	4,000	3,124	876	—
Direct Spanish Telegraph Company	2,332	1,492	840	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,677	29,661	4,016	—
Eastern Telegraph Company	48,824	51,206	—	2,382
Great Northern Telegraph Company	19,680	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,490	1,635	1,855	—

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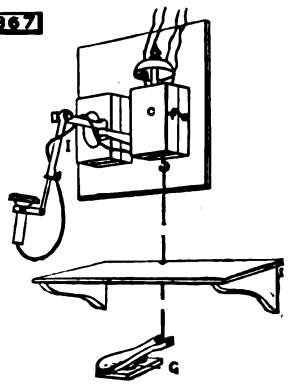
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2867. IMPROVEMENTS IN TELEPHONIC APPARATUS, *W. E. Potter, Liverpool.*—1*st July*, 1881. 6*d*.

The object of this invention is to obviate the necessity for replacing the telephone on a hook when a message has been received, in order to be in a position to receive a call, and also to be at liberty to use both hands to write with, instead of having to hold the telephone to the ear. The figure explains how this is done. When the pedal

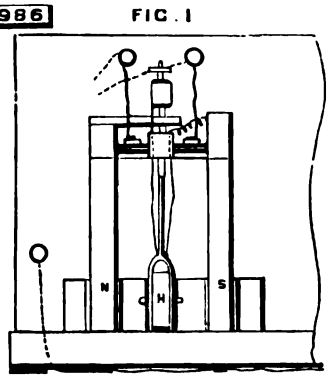


is pressed by the foot, so as to neutralise the action of spring G, a spring within the call box raises the switch, and the telephonic circuit is completed for receiving and transmitting. By means of the jointed holder I the telephone can be placed in any position, and the desk affords facilities for writing.

2986. IMPROVEMENTS IN TELEPHONIC SIGNALLING AND COMMUTATING APPARATUS, *J. Imray, London, 7th July*, 1881.—(*A communication from C. Ader, Paris.*) 6*d*.

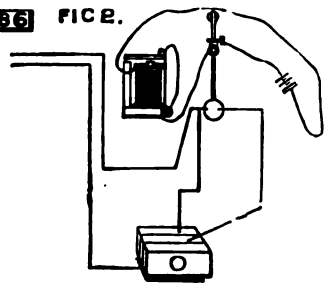
For signalling the inventor employs a solenoid coil with a core H, Fig. 1, suspended between the poles of a permanent magnet N S, and kept in position by an adjustable counterweight. When

2986 FIG. 1



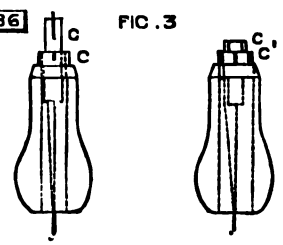
a current passes from a local battery, the coil moves to one side or the other, making contact by

2986 FIG 2.



means of platinum studs on it, with other fixed studs on either side, and so causing a signal to be operated indicating the subscriber who calls. To effect communication between two subscribers, the inventor uses two keys connected by conductors, and a commutator. The latter consists of three metal plates insulated from each other, and connected up as shown in the diagram, Fig. 2. Holes run through these plates, into which the keys are inserted. The keys present two split sockets *c c*^{1}, Fig. 3, insulated from each other, and connected to two conducting cords. When

2986 FIG. 3

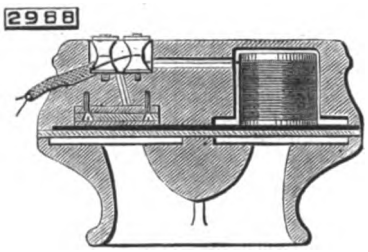


one key is put in, it connects the hinder to the front plate, and the other connects the middle to the front plate. By this means the exchange can communicate with a subscriber, excluding the relays, or two or more subscribers can communicate with each other by a circuit, including relays.

2988. IMPROVEMENTS IN TELEPHONIC APPARATUS, &c., *G. L. Anders, Boston, Mass.*—*7th July*, 1881. 8*d*.

The drawing shows a section of the inventor's combined transmitter and receiver, the first-named being of the Hunning's type, in which both are in circuit. By this means the inventor claims that the sound waves during transmission act equally on the receiver and practically eliminate its re-

2988

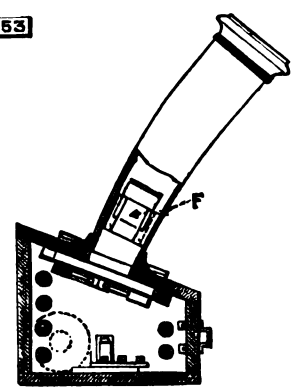


sistance besides conducing to clearness of articulation. The invention also relates to a method of operating signal bells, which is an improvement on a previous patent granted to S. Pitt, commissioned by G. L. Anders, and numbered 2674, 2nd July, 1879; also to an improved telephonic switch board, both of which are illustrated by drawings.

3053. IMPROVEMENTS IN BATTERY TELEPHONES, TRANSMITTERS, OR MICROPHONES, *L. Jacobson, Berlin.*—12*th July*, 1881. 6*d*.

The inventor applies a tube to the frame of the transmitter, so that the sounds are concentrated on to the diaphragm. If it is wished to modify the loud tones of the voice, slide F opens to any desired width and carries part of them off. The tube greatly prevents the transmission of other

3053



sounds than those of the speaker's voice. Various modifications of the above form of speaking tube are described and illustrated. The figure shows the ordinary form adopted by the inventor. The inside of the tube is lined with soft stuff to modify harsh tones, and a tube leads off the condensed breath.

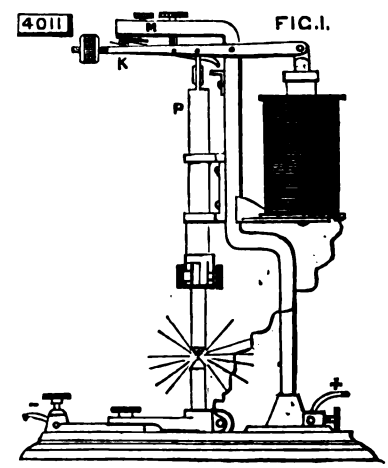
3177. IMPROVEMENTS IN THE INSULATED COATINGS AND COVERS, &c., FOR WIRES AND CABLES FOR TELEGRAPHIC PURPOSES, &c., *T. J. Mayall, Reading, Mass.*—21*st July*, 1881.—(*Not proceeded with.*) 4*d*.

The inventor employs a compound of india rubber and graphite. This is rendered plastic, cut into strips, and the wires enclosed in it, an external covering being afterwards wound round. The invention also refers to machinery for winding the compound round the wires.

4011. IMPROVEMENTS IN ELECTRIC LAMPS, *B. Hunt, London.*—17*th September*, 1881.—(*A communication from A. E. Brown, Cleveland, Ohio, U.S.*). 8*d*.

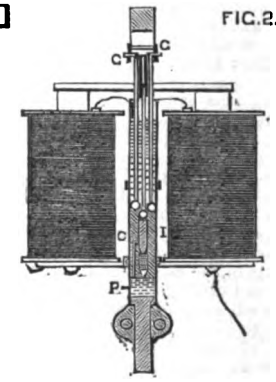
Fig. 1 shows an elevation and Fig. 2 a vertical central cross section of the method by which the inventor regulates his carbons. When the current is passing, and the arc established, a shunt

4011 FIG. 1.



current passes through F and F^1, H vibrates C, which lifts plunger, C, which, in turn, lifts the upper carbon. The free end of small lever L then makes contact with M by its nut K, the lever is turned on its fulcrum, so that its forked end lifts valvular plunger I, so as to open the ports of

4011 FIG. 2.

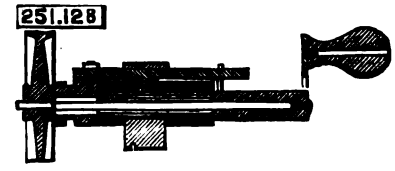


plunger C, and let out the glycerine, thereby allowing C to move readily in P, and the carbon to descend. Various modifications of this apparatus are also illustrated and described. The feed is constant, and is alternately increased or diminished as the current increases or diminishes.

251,128. MAGNETO-SIGNAL GENERATOR, *John B. Odell, Chicago, Ill.*—*Filed July 29th*, 1881.

Brief.—On the generator shaft are two collars, insulated from the shaft and from each other, and in electrical connection with each pole of the

251,128



generator respectively. These collars are normally connected by a spring bar, and the generator thus short-circuited; but the turning of the crank moves said spring-bar into an insulated position, thereby breaking the short circuit.

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SLIP

NEW COMPANY.—The Electric Fire Alarm and Signals Company has been formed, with a capital of £100,000.

TUNIS.—A Reuter's telegram dated Paris, April 13, says that a cable is to be laid along the Tunisian Coast from Djerba.

SOUTH AMERICA.—The Post Office has issued the following notice:—"The cable between Bahia and Rio de Janeiro is interrupted."

ELECTRIC LIGHT IN SOUTH AUSTRALIA.—The formation of the South Australian Electric Light and Power Company has been announced.

CANADIAN TELEGRAPHS.—A telegram from Ottawa, dated the 18th inst., says that the Dominion House of Commons has passed the Bill for consolidating the Canadian telegraph system.

ELECTRIC LIGHT IN BELFAST.—The Town Council have accepted the offer of Mr. J. H. Greenhill, of Belfast, to light a portion of Castle and Mill-streets with the electric light, free of charge.

PERSONAL.—Mr. John Walsh, retired divisional engineer of the Post Office Telegraphs, has recently completed an inspection of the National Telephone Company's wires in Bradford by the request of the Corporation.

ELECTRIC LIGHT AT LUTON (BEDS.)—The Pilsen arc lamp is used to light the Scientific and Domestic Exhibition which was opened last week at Luton. The Exhibition includes gas engines and electrical apparatus.

BATTERIES.—According to M. D'Arsonval battery partitions dipped into collodion will offer great resistance to the attacks of acids. The thickness of the collodion covering can, of course, be increased by repeated immersions.

ELECTRIC LIGHT IN MALTA.—It is now stated that the Brush light, which has been on trial at Valletta for some weeks, is to be continued as a permanency. The Eastern Electric Light and Power Company have the work in hand.

ELECTRIC LIGHT IN SHEFFIELD.—We believe that Messrs. Tasker, Sons, and Co., of Sheffield, and well known in connection with telephonic work, are about to form a local company for the introduction of the electric light into that town.

CITY AND GUILDS INSTITUTE.—We are glad to find that Mr. J. Perry, M.E., has been elected to the Chair of Mechanical Engineering at the City and Guilds of London Technical College, Finsbury, this week. We know of no one more fitted for the position.

CLYDE NAVIGATION TRUST.—A deputation of the Clyde Navigation Trust is now visiting the principal ports of England to ascertain, amongst other things, the extent to which the electric light is utilised for lighting purposes in harbours, and to report thereon.

THE TELEPHONE IN CEYLON.—According to the latest news from Ceylon, Mr. Leggatt, of the Oriental Telephone Company, had completed the preliminary arrangements for the establishment of a telephonic exchange in Colombo, and it would probably be in operation within a few months.

THE ELECTRICAL CONGRESS.—The International Electrical Congress, arising out of that held last year in Paris in connection with the Exhibition, at which the necessity of greater uniformity in scientific language, cable legislation, and other matters will be discussed, is announced to be opened in Paris on the 1st of May.

GREAT NORTHERN TELEGRAPH COMPANY.—Notice is given that the excess dividend for the year 1881 will be paid at the rate of 5s. per share, on presentation of coupon No. 10 for the year 1881, by Messrs. C. J. Hambro and Son, between 11 and 2, at 70, Old Broad-street, where lists are to be obtained, and coupons to be left three clear days for examination.

EXPORTS.—The value of telegraphic wires and other apparatus exported from the United Kingdom during the month of March was as follows in the last three years—viz.: £167,564 in 1880, £36,081 in 1881, and £384,271 in 1882, thus showing a large increase in this year's exports. For the three months ended March in the same years, the figures were—1880, £253,679; 1881, £99,784; and 1882, £454 861.

THE WEATHER AND THE TELEGRAPH.—During the early part of this week telegraphic lines generally have been put out of order by bad weather. In Scotland severe snowstorms caused an interruption to telegraphic communication. The cables generally were also in bad condition, so much so indeed that the morning papers were published without their usual money market intelligence from America and the Continent.

PERSONAL.—According to a Maltese paper, the Chevalier Edward Rosenbusch, representative of the Eastern Electric Light and Power Company in Malta, has had the order of St. Maurice and St. Lazarus conferred upon him by His Majesty the King of Italy. The same paper says:—"During his long stay in Malta the Chevalier Rosenbusch has introduced amongst us electric clocks and bells, the electric light, telephones, the electric pen, and many other novelties."

THE GERMAN UNION TELEGRAPH COMPANY.—This company has, we believe, completed the laying of the new cable, which will give direct telegraphic communication between Germany and America, and the ceremony of opening it will take place at Emden, from whence it starts to-day (Saturday). Dr. Stephan, Imperial Postmaster-General, will be present on the occasion. The cable runs from Emden to Valentia, where it is connected with one of the Anglo-American company's wires.

THUNDERSTORMS.—A heavy thunderstorm is reported this week from Bournemouth, during which a large house near Stapehill Monastery, Wimborne, was struck by lightning and badly damaged, though no one was hurt. Another storm appears to have visited Deal on Monday last, and is curious, from the fact that it was entirely local. It lasted about an hour and a half, between 10 and 11:30, and was very severe, though at present we have not heard of any damage having been done by the lightning.

ACTION OF ELECTRO-MAGNETS ON MINERALS.—Experimenting with electro-magnets on various minerals, Professor Doelter has made the interesting observation that the absolute amount of iron present does not determine the degree to which the minerals are attracted, for sulphides and sulphates containing much iron are very little attracted, while the attraction of oxides, carbonates, and silicates is strong. This varying amount of attraction, it is pointed out, may be of service in mechanical separation of natural mixtures of ores, purifying ores, &c.—*Nature.*

THE ELECTRIC LIGHTING BILL.—In the House of Commons on Monday Mr. Chamberlain, in moving the second reading of this Bill, proposed that it should be referred to a hybrid committee, nine members of which should be selected by the House and six by the Committee of Selection, and that all private Bills on electric lighting should be referred to the same committee. The Bill was then read a second time. A copy of the Bill and some remarks thereon will be found on another page. The names of the gentlemen nomi-

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nated by the House to serve on the Committee are as follow:—Mr. Chamberlain, Mr. Whitley, Mr. Slagg, Mr. Boord, Mr. Henderson, Mr. Henry Northcote, Mr. William Fowler, Mr. Molloy, and Mr. Brooks, and six by this Committee.

Electric Light at Peterborough.—On Monday last the Peterborough Exhibition was opened by the Earl and Countess Spencer, in the presence of a large and fashionable company. The building in which it is held is most brilliantly lighted by six Brush lamps, one of which is suspended within the lofty lantern on the roof, affording a naked light noticeable for several miles. In addition to the lighting of the exhibition, the principal streets of the city, including the market place, are illuminated by means of nine Brush lamps fed from the same dynamo. The whole of the lamps were erected within a week under the able superintendence of Mr. James A. Selby, an electrician of the Hammond Electric Light and Power Supply Company. The exhibition will remain open until the end of next week.

Bravery Rewarded.—We have pleasure in recording the fact that Mr. Alexander Dowling, in the employ of the Eastern Telegraph Company at Marseilles, has been presented, through the Foreign Office, with a medal and diploma from the French Government, accompanied by a complimentary letter from the chairman of the company, Mr. John Pender, M.P., in recognition of his bravery in rescuing during a gale the crew of a Chinese junk off Cape Stiyacque, Saigon, Cochin China. The vessel at the time was in a sinking state many miles out at sea, and the crew, consisting of 15 Annamites (French subjects), were completely exhausted from exposure and privations. Mr. Dowling was for ten hours engaged in the dangerous work, and on landing the Annamites he received the thanks of the Governor of Saigon for his courage and perseverance.

An Incipient Secondary Battery.—The following abstract of a paper, by J. B. Oster, in the *Chem. Centr.* for 1881, page 721, appears in the *Journal of the Chemical Society* for March:—"The author has constructed a powerful and permanent voltaic cell by covering sheet lead with a sufficiently thick coating of lead peroxide; the sheet is then wrapped in flannel, an anode of copper soldered on, and the whole rolled tightly in a cylinder. It is then enclosed in a wrapper of sheet lead, and introduced into a clay cell filled with dilute sulphuric acid; the cell is placed in a glass vessel filled with acid of the same strength, and containing amalgamated zinc plates. This cell gave a deviation of 70 degrees of the galvanometer for four days. The author proposes to modify this element, with a view of constructing a Faure accumulator, and has given notice of the patent."

A New Telephone Receiver.—The *Scientific American* describes and illustrates a new telephone receiver, the invention of Mr. H. S. Thornberry, of Winona, Minnesota State. The receiver consists of a spiral core placed inside an electro-magnet, and its action is due to the contraction or expansion of this core when a current passes in the electro-magnet. The core is attached at one end to the diaphragm, and at the other to an adjusting screw. The core is perfectly free to work in the helix, and the contraction or expansion of the spiral under the influence of the current from the transmitter acts on the diaphragm in much the same manner as though it were attracted by a magnet, the results being the same as in Bell's, Gray's, or Phelps' instruments. A permanent magnet placed outside the electro-magnet magnetises the spiral core and renders it very sensitive.

Commissioners of Sewers.—At the meeting of the Commissioners of Sewers in the Guildhall on Tuesday a proposition was put forward that the Streets Committee report upon "the practicability and expediency of the Commission laying down" conductors for the transmission of electricity for street, private lighting, and other purposes, and "the desirability of arranging the City in sections, to permit of such being periodically let by tender to electric light companies, with facilities for uniting any sections." It was likewise suggested that the Commission should acquire sites or premises for permanent stations for the machinery and plant required for the production of electricity to supply the City. These rather energetic propositions did not, however, meet with the approval of the majority of the Commissioners, and consequently were not adopted.

Royal Society of Edinburgh.—At this Society's meeting on Monday, Professor Blyth explained a communication "On the Action of the Microphone." In order to arrive at the cause of this action he thought the tremor and the air effects must be taken together; that the tremor effects produced a separation of the carbon points, and that, while the very minute electric arcs were passing between the separated points, the air effects came in and gave quality to the sound otherwise fully produced. For reasons which he adduced, they could hardly say that the tremor effects depended upon variations of resistance, due to change of pressure, but that when the particles of carbon were being carried by the electric current from the one carbon point to the other, these particles were affected by the sound waves, which thereby affected the electric arc and the resistance in the circuit.

Electric and Gas Lighting in New York.—According to an American contemporary, the following offers have been received by the authorities for lighting New York city for one year from the 1st of May, viz.:—The New York, Manhattan, Metropolitan, and New York Mutual Gas-light Companies, at the rate of 17·50 dols. per lamp per year; the Harlem Gas-light Company, 19·50 dols.; the Central Gas-light Company, 29 dols.; the Northern Gas-light Company, 32 dols.; and the Yonkers Gas-light Company, 30 dols. The Automatic Gas-lamp and Lighting Company proposed to light the lamps in Central Park, using naphtha, for 27 dols. each per year. The Brush Electric Light Company proposed to light certain streets at 70 cents per night for each lamp. About 272 lamps would be required to light these streets. The same company offered to light High Bridge for 1 dol. per lamp per night. The United States Electric Light Company tendered for lighting Broadway from Battery Park to Fourteenth-street; Battery Park, City Hall Park, Fifth Avenue from Washington-square to Fourteenth-street, and Washington-square, at the rate of 70 cents per night for each lamp. The acceptance of a tender was deferred.

The Atlantic Cables Question.—The late coalition between the representatives of the various cable companies is thus criticised by a shareholder of the Anglo-American Cable Company, in the *Daily News* of the 18th instant. After alluding to the fact that the company propose to absorb the two cables of Mr. Jay Gould, by giving him 22 per cent. of the aggregate gross receipts of the Atlantic cables, the writer continues:—"The gross receipts of the Anglo Company for the past year were £517,000, at an average tariff of 1s. 7d. per word. The working expenses (including appropriation to renewal fund) were £266,000, or 52 per cent., leaving an available revenue of £251,000. 22 per cent. of the gross receipts would give Mr. Gould £113,740, reducing the profits of the Anglo shareholders to £137,260, or barely enough to pay $1\frac{3}{4}$ per cent. dividend. These figures are based upon the assumption that the tariff is raised to at least 1s. 7d. per word, or rather, I should say, 2s., as last year's receipts were enormously augmented by the Garfield news. It appears to

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me that the proposal will inevitably invite fresh competition, and that any further attempt to perpetuate a monopoly of Atlantic telegraphy can only add fuel to the fire. We had far better face our altered position at once."

AN INSULATOR FOR UNDERGROUND WIRES.—Mr. W. A. French, of Camden, New Jersey, U.S.A., has invented a new method of insulating underground wires. The outer casing consists of a tube of hard rubber made in 10ft. lengths and of a diameter suited to the number of wires to be used. The ends of the tubes are united by a water-tight joint. Short connecting tubes, made in halves, join the longer lengths and admit of being removed to insert or remove the conductor. The lengths of large tubing are filled up with smaller tubes of soft rubber, which project a short distance from the ends of the large tube into the connecting tubes, where they meet the ends of the corresponding tubes of the adjacent section, and are connected by a short coupling of hard rubber. The small tubes are of such size as to admit of readily inserting and removing the telegraph wire. In practice the wires are passed through the small soft rubber tubes of a number of hard rubber tubes, which are placed at such a distance apart that the ends of the soft rubber tubes will meet. The ends of the corresponding tubes are then connected by the small hard rubber couplings. The divided connecting tubes are then applied to the adjacent ends of the hard rubber tubes, and the coupling bands are screwed on the collar, the joints being made tight by cement or packing.

AURORA IN THE UNITED STATES.—A telegram from the correspondent of the *Standard*, dated New York, Monday night, says:—"Aurora of remarkable extent, brilliancy, and grandeur was witnessed last night. Despatches show that it was observed over an immense territory. From Cheyenne, New Orleans, and the British Provinces atmospheric disturbance is reported. The telegraph sometimes worked without batteries; sometimes it was unsafe to use it at all. The colours are reported yellow, pink, blue, blood red, and silvery. In Cleveland, Ohio, there was a general complaint of an oppressive sensation, similar to that attending an earthquake. Ministers were prostrated in their pulpits, and ladies fainted. At New York, early in the evening, a greenish arch spanned a wide arc of the northern horizon. Later on rosy shafts in the east, west, and north formed a crown about Arcturus, which was constantly wavering and flickering. Sometimes immense areas of light suddenly appeared in a perfectly black sky, paling the stars, and, tremulously advancing through the heavens, melted into the crown near the zenith. After midnight a light equal to sheet lightning appeared. The crown was perfect, encircling a patch of sky within. Arcturus was undimmed, but the other stars were extinguished. It was an exceptionally beautiful sight."

TELEPHONES AND ELECTRIC LIGHTING IN BRAZIL.—The *Rio News* of recent date says:—"Ever since the telephone company of this city—which is so unfortunate as to be a foreign enterprise—began to stretch their lines from the central office to the various suburbs, there has been a systematic effort on the part of certain interested parties to impede the work and damage the property. The means usually employed is the cutting of the wires. Regardless of the fact that this is an injury to private parties as well as to the company, this contemptible work has been prosecuted not only without hindrance, but with the well known approval of influential parties in this city. . . . If a privilege to a foreign enterprise is worth one straw in Brazil, then the Government is bound to guard and protect it. If, however, a foreigner has no protection for his labour and investments as against the malice of influential personages, then let us know it at once. If matters go on in this way a little while longer—in the confiscation of property, the breach of contracts, the destruction of electrical machines (this refers to a systematic attempt to destroy the Edison Company's machine at a recent exhibition), and the cutting of telephone wires—this country will be saddled with a reputation which will not only keep enterprise and capital at a distance, but will even drive away those that are now here."

THE TELEGRAPH AND FISHING STATIONS.—The special correspondent of the *Colonies and India*, writing from St. John's, Newfoundland, on 20th February, says:—"A measure for connecting our principal fishing ports and bait stations by telegraph is likely to come before the House, and is one which must be of great benefit to our fishermen. The comparative failure of our Labrador fishery last season was due mainly to the want of this valuable auxiliary. The uncertain movements of the fish that yearly come to our shores, both as regards time of year and locality, render it almost impossible for our fishermen to divine the spot most likely for them to secure a catch. The telegraph system will put an end to this trouble, and will, as at present in Norway (where the late successful fisheries are mainly due to this agent), indicate to the fishermen the exact spot where the shoals of fish are. This system of telegraphy has, in the past year, been of the greatest use to our sealing captains in the prosecution of the seal fishery. The Anglo-American Telegraph Company in 1878-9 laid wires along our principal northern bays, and, in some instances, out to our capes, from which daily telegrams are received for two months or so previous to our sealing fleet starting, setting forth the position of the ice and seals, and the prevailing winds and other influences; and in many cases the intelligence thus afforded has been of the utmost value."

A REGULATOR OF GAS PRESSURE.—M. J. Ville has constructed an apparatus for keeping the flow of gas at a certain pressure. The apparatus consists of a mercury manometer of special form, one branch of which encloses the gas at a fixed pressure, which will remain constant as long as required; the other branch communicates with a storing vessel. It may be stated here that the regulator is placed between the vessel from which the gas is to be drawn for use and a reservoir of gas under pressure, the pressure in this latter being always higher than in the former. When the pressure in the former decreases, the regulator causes the necessary quantity of gas to compensate for this decrease, and pass from the reservoir into the vessel. The action of the regulator is as follows:—If a decrease in pressure takes place in the vessel, the mercury rises in the manometer tube, and makes contact with a nickel-plated steel rod, insulated in the axis of the tube. This causes a current to flow to an electro-magnet. This latter attracts an armature, to which is attached a valve, which being thereby lifted, permits a certain quantity of gas to pass from the reservoir into the vessel, sufficient to compensate for the decrease in the latter. Equality of pressure having been restored in both branches of the manometer, the mercury falls, ceases to make contact with the rod, and the current ceasing, the valve is released and resumes its former position. An apparatus constructed by M. Ville resisted pressures of 15 atmospheres, and its electro-magnet would resist an excess of pressure of two.

THE HEATING OF ELECTRODES BY INDUCTION SPARKS.—*Wiedemann's Beiblätter* gives a description of some recent experiments made by Herr Naccari to determine the amount of heat generated in the electrodes by the passage of a spark from an induction coil. He employed two metallic vessels of 5 centimetres diameter, mounted on glass rods, so that they

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could be moved to or from each other. These vessels, which had thin sides, were each filled with petroleum, in which a thermometer, graduated to fiftieths of a degree, was submerged. Moreover, the liquid in the vessels was agitated by means of a special arrangement for that purpose. One of the vessels was connected with one of the poles of an induction coil giving sparks of 48 centimetres, and the other vessel with the other pole; in this latter part of the circuit, however, a galvanometer was inserted by means of which the intensity of the discharge could be ascertained. The following results were obtained:—(1) The negative electrode was heated to a greater extent than the positive. (2) So long as the distance between the electrodes did not approach the limiting distance at which sparks could pass the heat generated in each electrode was proportional to the intensity, that is, to the quantity of electricity which passed. (3) The nature of the metals forming the vessels had no particular influence on the amount of heat developed. (4) When the distance between the electrodes was increased, the intensity remaining constant, the heat in each electrode increased up to a maximum; it then diminished, and gradually decreased to unity. (5) The quantity of heat given off was, relatively speaking, great.

Refraction of Electricity.—Experiments carried out by Mr. A. Tribe, and recorded in the *Proceedings Royal Society*, to ascertain whether electricity is endued with the property of refraction, have given the following results:—(1) Electricity, in passing obliquely from one medium to another, is refracted towards the perpendicular when from a better to a worse conductor, but from the perpendicular when from a worse to a better conductor; (2) The refraction increases or decreases according to the relative conductivity of the two media; (3) The refraction increases as the angle of incidence increases, it being probable that the sines of the angles of incidence and refraction are in constant ratio. (With reference to this, Professor Stokes appends a note, pointing out that, according to theory, the tangents, not sines, of the angles of incidence and refraction are in constant ratio, but owing to the introduction of errors, the numbers adduced cannot be deemed sufficient to decide between the laws of sines and tangents. Further, in the case of the second medium being the better conductor, the law of sines would lead to extravagant results.) The method of conducting the experiments was as follows:—Two sheets of gutta percha were fixed across an electrolytic cell of copper sulphate, inclined at an angle of 45° to the base line; into the inner cell enclosed by the gutta percha walls a 1 per cent. copper sulphate solution was introduced, and in the outer cells a concentrated solution of the same salt. The distribution of energy was recorded by the immersion in both cells of rectangular silver plates, called analysers, placed lengthwise in several parts of the central line joining the electrodes. A unit current was employed, and copper electrodes of the breadth and depth of the outer cells.

Action of Telephonic Currents on the Galvanometer.—The following note of M. Chardonnet, being an extract from a letter by M. A. Cornu, is published by *La Lumière Electrique*:—"If the receiver in a telephonic circuit be replaced by a very sensitive galvanometer, and the transmitter be acted on by a tuning-fork, pitch pipe, or the voice, no deflection will be noticed so long as the same intensity is preserved; but, on the sound being increased or decreased, the needle is deflected, the deflection changing in character according as the amplitude of vibrations of the sonorous body is in the act of increasing or decreasing. The effect is more marked when the transmitter is agitated by a noise of short duration, such as an explosion, or by a heavy body striking the vibrating disc. In this latter case the needle of the galvanometer springs like the second-hand of a clock. The experiment of quickly increasing or decreasing the distance between the sonorous body and the transmitter succeeds equally well. The deflections are naturally more marked when a microphone transmitter, such as Ader's, is used, but they are visible with every kind of telephone. The explanation would appear to be simple:—So long as the oscillations of the vibrating disc preserve the same amplitude, and in consequence the same speed, the alternate induced currents of different characters at each complete vibration counteract one another on the galvanometer, whether they are emitted by an electro-magnet or a microphone. But if the vibrations tend towards zero, for instance, each odd half-vibration has a greater amplitude than the succeeding even half-vibration, and the induced currents of different characters do not, each pair of them, set in motion the same quantities of electricity. The residues of the same sign at each complete vibration accumulate and deflect the needle of the galvanometer, the deviation being as much greater as the sound decreases more rapidly."

The Electrolytic Deposition of Lead.—Some years since Mr. N. S. Keith, of this city, says the *Engineering and Mining Journal* of New York, proposed a method of desilverising base bullion by electrolysis. Although Mr. Keith has since modified his plans so that his process is now confined to the rich lead-zinc silver alloys produced in ordinary zinc desilverisation, an experiment made at Clausthal, Germany, by Dr. H. Hampe will be of interest. Before referring to the figures arrived at by Dr. Hampe, we may state that he has pointed out some defects in the original process, and it would be of interest to learn whether and how far they affect the modified plan. Dr. Hampe states that the deposit of lead on the cathodes, growing gradually, penetrates the canvas bags, and easily forms a metallic conductor between the electrodes. He suggests that some stripping device be employed to counteract this tendency. An important point brought out by Dr. Hampe, however, is that the lead deposited is by no means pure, other impurities, and notably bismuth, being deposited with the lead. Much zinc, too, goes with the lead, notwithstanding the fact that there is an excess of lead, which Mr. Keith claimed would prevent it. Dr. Hampe suspended three plates of impure lead—which we may state is not worse than a large proportion of the base bullion going to our refineries—in six liters of a solution of acetate of lead, containing 77·92 grams of lead per liter, and acidulated with about 4 per cent. of acetic acid. The surfaces of the electrodes amounted to 13,000 square millimeters. After the current of two Meidinger-Pincus cells having approximately a zinc surface of 39,000 square millimeters had passed through for 456 hours, the quantity of lead deposited amounted to about 680 grams, while the silver residue in the canvas bags weighed about 11 grams. Analysis of the base bullion and of the products yielded the following results:

	Base bullion. Per cent.	Lead deposited. Per cent.	Silver residue. Per cent.
Lead (by difference)..	98·79767	99·99297	23·97
Bismuth	0·00376	0·00305	11·20
Copper	0·37108	0·00060	14·44
Antimony	0·55641	0·00099	29·70
Silver	0·25400	—	18·435
Tin	0·00575	0·00041	trace.
Nickel	0·00730	—	0·090
Zinc	0·00271	0·00198	1·80
Sulphur	0·00132	—	—
	100·00000	100·00000	99·635

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ENGINES AT THE CRYSTAL PALACE.

We recently (in our issue for April 1) gave illustrations of one of Messrs. Davey, Paxman, and Co.'s engines, as used to drive the dynamo machines in connection with Messrs. Hammond and Co.'s exhibit of Brush lights at the Crystal Palace. We are now, by the courtesy of our contemporary, the *Engineer*, enabled to give illustrations of another engine which is employed at the Crystal Palace to drive electric light machinery, so that our readers will thus be able to easily compare them one with another, and judge as to their respective merits.

Messrs. Fowler and Co.'s Engine.

Figs. 1 and 2 illustrate a semi-portable engine of 25 horse-power nominal, built by Messrs. J. Fowler and Co., of Leeds. This engine has two cylinders, one high pressure, 9½in. diameter, and one low pressure, 16in. diameter, the stroke of

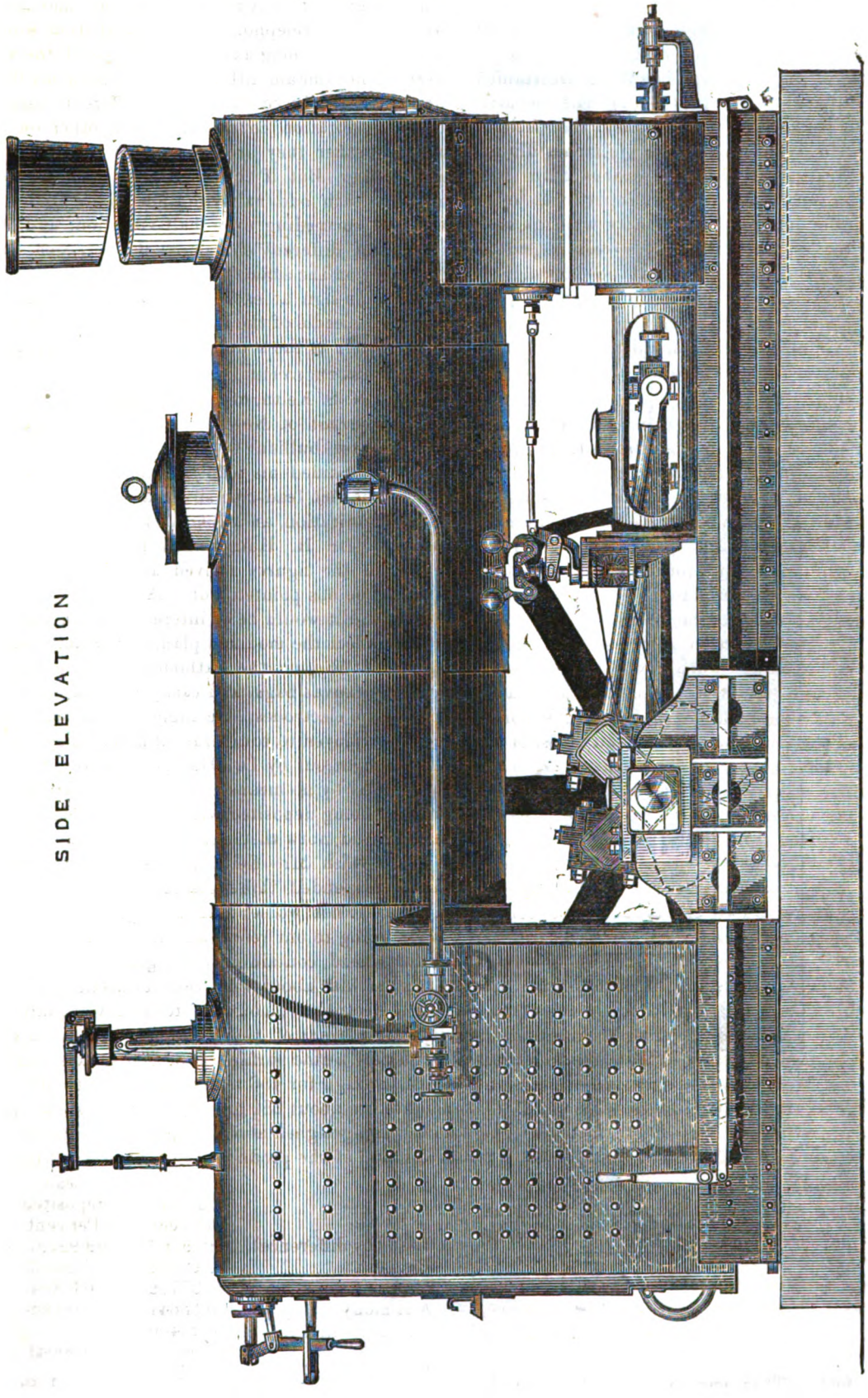

Fig. 1.—Fowler and Co.'s Engine.

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both of which is 18in. The number of revolutions of the driving wheel per minute is 120. The grate surface is 12 square feet, and the total heating surface 355·8 square feet, made up as follows, viz. :—Fire box, 52·8 square feet; and nearly 50. The engine has two fly wheels, shown in Fig. 2 but not in Fig. 1, and is fitted with a sensitive governor of the Buss type. It is said to run very steadily, and give regular turning. It will be found in the shed at the side of

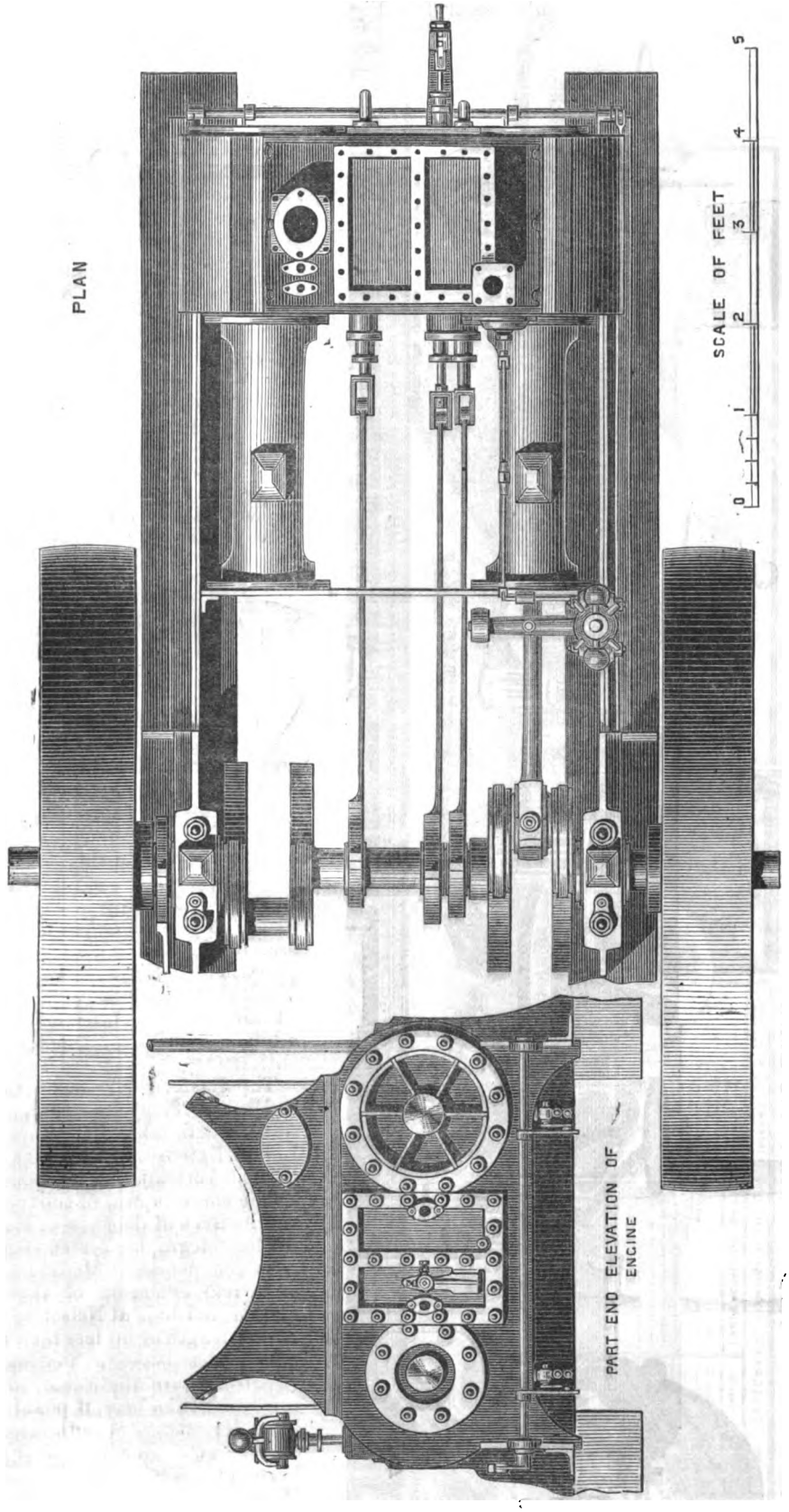

FIG. 2.

tubes, 303 square feet. That engine drives two No. 7A Brush machines, supplying current to 32 arc lights. The fire-box of this engine is made extra large, to burn inferior fuel. The indicated horse-power is said by the makers to be the corridor leading from the Low Level Station at the Palace, close to Messrs. Davey, Paxman, and Co.'s engine referred to above, and forms a part of Messrs. Hammond and Co.'s exhibit.

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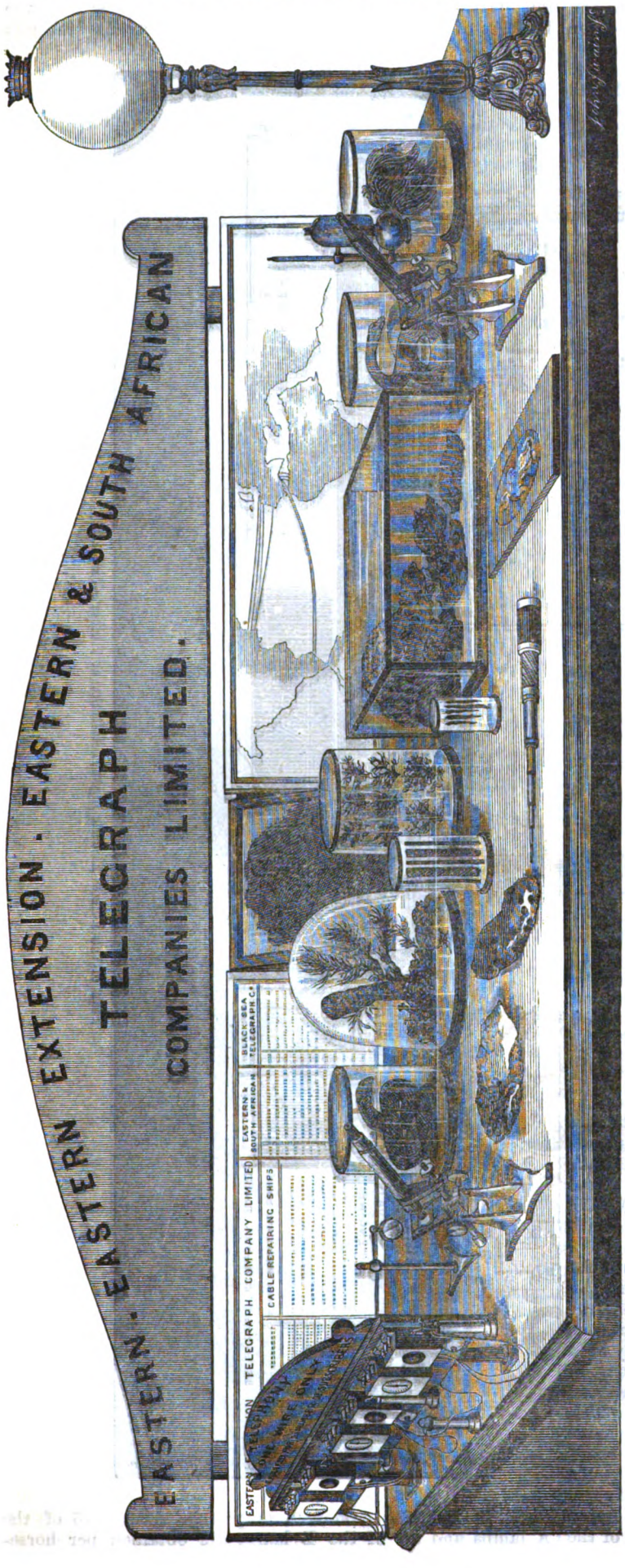
CRYSTAL PALACE EXHIBITION.—*Eastern, Eastern Extension, & Eastern & South African Companies' Exhibits.*



Francis Gisborne, writing in those admirable Quarterlies, *Cambridge Essays*, in 1857, commenced an article on "Telegraphic Communication with India" with the following words:—"Railways have superseded roads and canals for the conveyance of passengers and light goods; the electric telegraph has superseded railways in the conveyance of intelligence. The mechanical genius of this age has enabled man to apply to his purposes the power that pervades all space, and seems, by its wonderful properties of traversing inconceivable distances, and producing its effects in fractions of time that can hardly be calculated, rather to belong to infinity than to this world. Yet so it is. Providence has suffered this wonderful element to become the servant of mankind; and the 'dominion' given to Adam 'over the fish of the sea, and over the fowl of the air, and over every living thing that moveth on the earth,' seems, in these days, to be extended to that which especially appertains to regions beyond the earth. A mechanical contrivance, called the electric telegraph, produces, transmits, and registers at the close of its career, the effects of the electric current." The author, after a few more sentences, said:—"As yet, however, the telegraph does not connect distant parts of the world." These words were written, be it remembered, only a short 25 years ago, by a gentleman whose name is well known to all pioneers in telegraphy. Contrast the state of telegraphy now with what it was then. Now Australia, China, and Japan on the one side to the far east are linked with America on the far west, through Europe, aye, through Great Britain, and these "links" have been made and retained by the enterprise of British capitalists. Whilst we are writing an ordinary meeting of one of the great companies is being held, and we have no doubt the shareholders will be gratified at what is told them—for these companies are renowned for good and careful management.

We illustrate in this number the stand at the Exhibition where are the exhibits of the Eastern Extension Company. The adjoining stand, that of the Eastern Company, shows the instruments used in the working of cables, while the Eastern Extension Company's stand shows the enemies which the owners of cables have to guard against. Of course, these statements only refer to the exhibits generally, both companies showing specialities.

The Eastern Extension Company was formed in May, 1873, by the amalgamation of the three trans-Indian telegraph companies, viz., (1) British Indian Extension, (2) China Submarine, and (3) British Australian Telegraph Company.

The share capital of the company is £1,997,500, and its issue of debentures amounts to £1,060,000.

The telegraphic system belonging to this company commences at Madras, acting in fact the part of a real extension of the Eastern Company's system, and ends at Nelson in New Zealand, having a total length of no less than 10,376 miles of cable. The cables between Penang and Port Darwin (Australia) are duplicated, so that any failure of communication may, if possible, be obviated, there being less chance of both cables developing a fault at the same time than at different times. Since 1878 the system has worked duplex between Madras and Penang with every satisfaction. We believe the duplex arrangements were carried out by Messrs. Clark and Muirhead.

The company own two repairing vessels, (1) ss. "Agnes," 559 tons registered, and (2) the ss. "Sherard Osborne," 875 tons registered. These

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vessels are kept in the Eastern seas, so as to be at hand when their services are required. Besides these ships, the company has also a hulk, the "Southern Ocean," used for storing cable and other apparatus, stationed at Singapore.

The company has fourteen stations, viz., Madras, Penang, Rangoon, Malacca, Singapore, Saigon, Hong Kong, Manila (Island of Luzon), Batavia (Java), Banjoewangoe (Java), Port Darwin (Australia), Sydney (New South Wales), Nelson (New Zealand), George Town (Tasmania), and agencies at Adelaide and Shanghai.

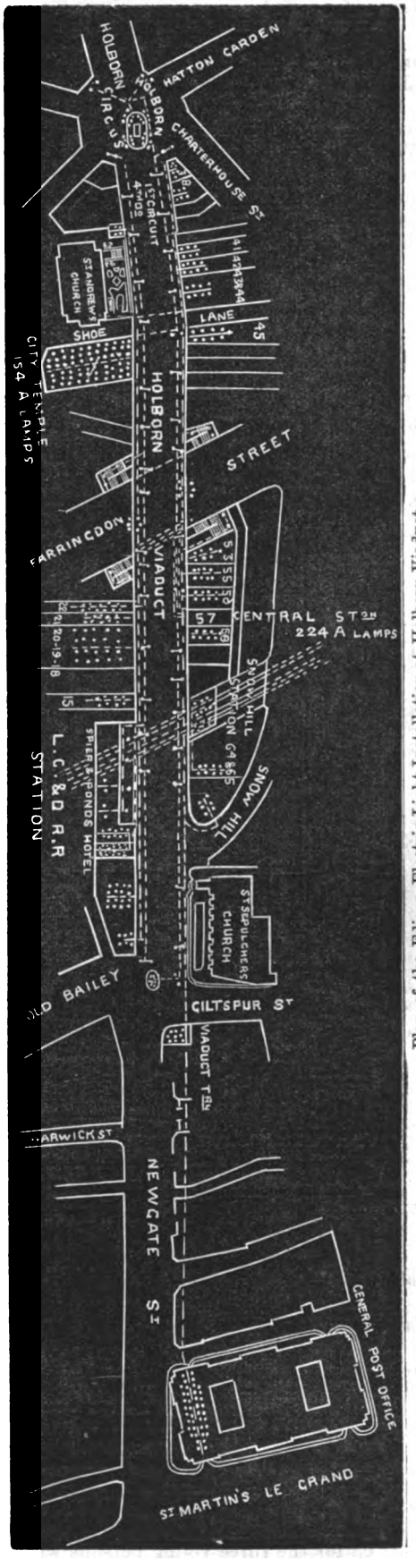
Thus the new England of the Antipodes is linked through India, our greatest dependency, to the mother country, through these little cables that lie on the bed of the ocean. Electricity has given us the means to speak through twice ten thousand miles without delay or difficulty. But the lines are kept in order only by careful and constant watching. Storms, earthquakes, the denizens of the sea, all contribute dangers to the cables. The ingenuity of man has been severely tried to obtain a cable conductively and inductively perfect, that should defy the ravages of time and worms, for it seems that, in addition to that very troublesome enemy in the seas wherein lie this Company's cable, "the teredo," much damage is occassioned by a boring worm recently discovered inside the iron wires of the cable, specimens of which are shown among the exhibits. In order to prevent faults arising from the work of these animals, long lengths of a special cable have been made, which, besides the ordinary insulating and protecting coatings, is wholly surrounded with a brass tape. A specimen of this cable is shown.

If the reader is interested in the various types of cable, an excellent display will be found in the case shown by the Telegraph Construction and Maintenance Company, which manufacturers have made all the cables of the Eastern Extension Company.

THE EDISON LIGHT AT HOLBORN.

In our last issue we mentioned the commencement of the public working of the Edison incandescent lamps at Holborn. It will be remembered that Mr. Edison has devoted his energies almost entirely to the construction of a complete system of incandescent lighting. He believes the work of the arc lamp, with its enormous candle-power, to be extremely limited when compared with the opening for lighting by incandescence. We have seen and appreciated the brilliant lighting by means of the arc lamps. We are now able to contrast street lighting by their aid with that obtained from the Edison lamps. The lighting of streets, however, is of secondary importance—the great question is, Can we light our houses with this pure light with some approach to economy? We do not think the future of the electric light depends on the ability to distribute it under the current prices of gas. It is nonsense to suppose that a householder now paying £50 a year for gas will make much fuss about an extra five pounds if it should be found necessary (which, however, we deny will be the case). He will prefer the electric light for a number of reasons which we need not enter into here.

Mr. Swan has previously used the incandescent lamp for street lighting at Newcastle-on-Tyne, but to the energy of Mr. Edison we owe the first installation upon a scale large enough to once for all show what can be expected from such lights. The generating apparatus at Holborn has already been described by us, as has Edison's lamp and connections, so that at present we shall confine ourselves to giving the plan of the scene of operation, with a few details as to circuits. We ought, however, to say that the second Edison dynamo has been erected at Holborn, and either of the machines is sufficiently powerful to supply the current required by the lamps. Most of the lamps used are those called A lamps, having a candle-power of about 16 candles, but some few B lamps of half this intensity are used. The resistance of the A lamps (hot) is about 125 ohms, the B lamps having about half this resistance. The E.M.F. of the current required for the A lamps is 110 volts, and this is the E.M.F. of Mr. Edison's dynamo, the current through



Plan of the Edison Electric Light Installation at Holborn Viaduct.

each lamp being about ·8 amperes. About 10 of the A lamps and 20 of the B lamps are obtained per horse-power. As the A lamps are all arranged in single multiple

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arc, the reader can always obtain an approximate idea of the resistance of the circuit by dividing the resistance of one lamp by the number of lamps.

$$\text{Resistance of circuit} = \frac{\text{resistance of lamps}}{\text{number of lamps in circuit}}.$$

The arrangements at Holborn have been carried out by Mr. E. H. Johnson, manager for Mr. Edison in this country, and Mr. J. Hammer, engineer. The plan of the streets, &c., lighted, given hereunder, will enable readers to trace the circuits. We shall be better able to judge of the value of these lights when the whole arrangements are complete, it being intended, we believe, to place a lamp of greater candle-power in the streets. The following tables show how the various lights are distributed :—

		A.	B.	Total
Streets, Bridges, Stair Towers, &c.	1st circuit	66	—	
	2nd „	40	—	
	3rd „	27	—	
	4th „	31	—	
Buildings				164
1st Circuit. No. 38	Negretti, Zambra	11	—	
38	Sharp and Co	25	—	
41	Vaseline Company	6	—	
42	Hodge and Essex	8	—	
43, 44	Holland and Co.	8	—	
45	Steel and Garland	9	—	
53	W. D. and H. O. Wills.	10	—	
55	Terry and Co.	5	4	
56	J. Buck	12	—	
				78
2nd Circuit... 58	H. S. Ward and Co.	11	—	
61	Smith and Son	8	—	
62	Dreydell and Co.	3	—	
63	Boyle and Co	9	—	
64, 65	Jenks and Wood	12	—	
60	City Rubber Stamp Co.	6	—	
				49
3rd Circuit... 3	Monington & Western.	16	—	
	Imperial Hotel	13	14	
	London, Chatham, and Dover Railway	9	—	
	Spiers & Pond's Restaurant	20	—	
	Spiers & Pond's Hotel	48	—	
15	Coventry Machines Company	7	—	
18, 20	Perry and Co.	24	—	
21	Pall Mall Electric Association	9	—	
22	Meriden Britannia Company	5	—	
	Holborn Land Co.	4	—	
	Levy and Nephew	3	—	
				162
4th Circuit...	City Temple	147	14	
	Lusher and Son	7	4	
				172
Central Station 57		216	16	232
Viaduct Tavern		9	22	31
General Post Office		50	—	50
	Grand Total			938

THE RECENT ALPINE ACCIDENT.—The Vienna correspondent of the *Standard* says that the electric light was used in the recent search for the three young persons who lost themselves during an attempted ascent of the Rax Alp, near Pegerbach. Though the use of the light was not successful, the idea certainly seems to have been good. The missing three were found half starved some days after.

REPORT ON EXPERIMENTS WITH FAURE'S SECONDARY BATTERY.*

BY MM. ALLARD, LE BLANC, JOUBERT, POTIER, AND TRESCA.

A preliminary experiment was tried at the Exhibition on the 20th October, 1881, under conditions requested and arranged by M. Faure. The battery was composed of 40 cells; it should have kept alight, during its discharge, 16 Maxim lamps, but the attempt soon broke down. The intensity of the current and that of the light decreased with great rapidity. The experiment, begun at 7:40 p.m., with an intensity of 3·45 carcels per lamp, came to an end after 1 hour and 20 minutes, when each lamp gave but one carcel. M. Faure attributed this failure to defects in the arrangements and to the bad condition of the cells, four or five of which were discharged by themselves whilst in action. The Commission agreed to repeat the experiments under conditions and with apparatus which M. Faure should consider most likely to bring about good results. These experiments were carried out at the Conservatoire des Arts et Metiers, in the large machine room, on the 4th-9th January last, and may be considered as a continuation of those begun at the Exhibition.

The battery placed at the disposal of the Commission consisted of 35 cells, new form, with spiral plates, each of which weighed, with its liquid, 43·7 kilograms ; the lead electrodes were covered with minium to the extent of about one kilogram per square metre. The liquid was formed of distilled water and one-tenth part of pure sulphuric acid.

The charging machine, also lent by M. Faure, was one of Siemens's. The resistance of the armature was ·27 ohm, and that of the inductor 19·45 ohms. The electro magnet was excited by a shunt circuit from a terminal of the same machine. To regulate the current M. Faure had interposed a kind of voltameter with carbon electrodes, in which he varied the resistance by modifying the quantity or character of the liquid. During the whole of the experiment the exciting current remained, owing to this arrangement, between two and three amperes.

The principal aim of these experiments was to measure:— 1. The mechanical work expended in charging the battery; 2. The quantity of electricity stored up during the charging ; 3. The quantity of electricity given off in discharging ; 4. The electrical work actually done during the discharge. It was necessary, moreover, to know at any moment the E.M.F. and resistance of the battery, and also, as the discharge was made to traverse a series of Maxim lamps in a state of incandescence, to ascertain the variation in the resistance and luminous power of these lamps, in relation to the intensity of the current. The mechanical work was measured by means of a totalising dynamometer, constructed by Messrs. Easton and Anderson for the Société des Agriculteurs de France, on the model of that adopted by the Royal Agricultural Society of England. The luminous intensity was taken by a Foucault photometer, which had been used in other experiments by the Commission.

The electrical measurements were made by the following instruments :—A Deprez galvanometer, which measured the total current, and sometimes the exciting current; a Siemens electro-dynamometer, which measured the charging current only, and a dial electrometer, arranged according to Joubert's method, indicated the difference of potential between the two poles of the battery. (To insure the more complete control of all the observations the record register during the whole of the experiments was rendered accessible to M. Faure.) The readings of all the instruments were taken simultaneously every quarter of an hour ; during the latter portion of the experiments, when the variations were more marked, the readings were taken every seven and a half minutes.

Calculation of the Average Intensity of the Quantity of Electricity.

The average intensity corresponding to a long interval of time is the arithmetical mean of the intensities indicated every quarter of an hour during this time. The product of this mean intensity, and the number of seconds elapsed, expressed in amperes, gives the quantity of electricity set in motion during the period of observation in coulombs :—

Date.	Mean Intensity.	Seconds.	Coulombs.
4th January	10·930	19,800	216,400
5th „	7·970	25,200	200,800
6th „	7·936	27,000	214,300
7th „	6·360	9,900	63,000

The same calculation must be made for the exciting current to serve as a basis for the final conclusions.

Mean Intensity.	Seconds.	Coulombs.
2·46	19,800	48,700
2·81	25,200	72,800
2·33	27,000	62,900
2·18	9,900	21,600

* Presented to the French Academy of Sciences on the 6th March by M. Tresca. Translated from *La Lumière Electrique*.

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Calculation of Electrical Work.

So long as the difference of potential between the two terminals of the battery remains constant, the electrical work of the charge or discharge in a given time is equal to the product, divided by g, of the quantity of electricity, and this difference of potential. When the latter varies, it is necessary to multiply each intensity by the corresponding difference of potential, again divided by g, and to take the arithmetical mean of all the results. The calculations by which the figures in columns 8 and 9 of Table I., and column 5 of Table II. have been arrived at were made in this way. Column 8 represents the electrical work T′ expended in causing the quantities of electricity stored during the charging to enter the battery.

Electrical Work during the Charge.

Date.	Difference of Potential.	Quantity of Electricity.	Corresponding Work.
4 January	82·21 ...	216,400 ...	1,814,600
5 ,, ...	91·08 ...	200,800 ...	1,947,100
6 ,, ...	92·91 ...	214,300 ...	2,028,800
7 ,, ...	92·06 ...	63,000 ...	591,600
			6,382,100

Column 9 represents the work T″ expended in exciting the electro magnets.

Electrical Work Expended in Exciting.

Date.	Difference of Potential.	Quantity of Electricity.	Corresponding Work.
4th January	82·21	48,700	408,400
5th ,, ...	91·08	72,800	676,300
6th ,, ...	92·91	62,900	596,100
7th ,, ...	92·06	21,600	202,800
			1,883,600

Col. 10 gives the value of the electrical work T‴ expended at the armature; it has been calculated for each day by multiplying the resistance of the armature, ·27, by the square of the total intensity observed on the galvanometer, and by the number of seconds.

Res. of Armature.	Intensity of Current.	No. of Seconds.	Electrical work at the Armature.
·27	13·29	19,800	94,400
,, ...	10·78	25,200	79,100
,, ...	10·26	27,000	76,800
,, ...	8·54	9,900	19,500
			269,800

It may be remarked that on totalising these different electrical works, and adding the work of transmission, measured directly, we have as follows, to about 2 per cent. nearly, the work T recorded on the dynamometer.

T	= 9,569,798		
T′	= 6,382,100	T′ : T	= ·666
T″	= 1,883,600	T″ : T	= ·197
T‴	= 269,800	T‴ : T	= ·028
t	= 808,750	t : T	= ·085
	9,349,250		·976

E.M.F. and Resistance of Battery.

The E.M.F. of the battery is given directly by the electrometer reading when the circuit is open. Let E be this value, e the reading of the electrometer when the circuit is closed, and when the intensity of the current is I. Lastly, let R be the resistance of the battery, we shall have $e = E \pm R I$, according as the battery is being charged or discharged. If we know the values of E, e and I at the same moment, we can calculate that of R, which measures the sum of all the resistances.

During the charge the value of E varied from 72 to 75·8 volts, that is to say, for each cell from 2·057 to 2·165; that of e averaged a little less than 90 volts, the mean intensity of the current being 8·55 amperes. During discharge the value of E was lowered from 75·6 to 72 volts; that of e was reduced to about 60 volts, with a mean intensity of 16·16 amperes. The resistance of each cell during the charge varied from ·023 ohm to ·075; during discharge, from ·006 to ·040; at the beginning of the discharge the change in the character (*sens*) of the current caused this resistance to fall suddenly from ·075 to ·006.

(The resistance R, calculated by the formula which precedes the figures obtained by observations made at short intervals, for E e and I, is the apparent resistance of the battery. It is not impossible that a considerable proportion of the variations was owing to some phenomena of polarisation.)

Resumé of the Period of Charging.

The charging of the battery occupied 22h. 45m., and was accomplished at five different operations. Table I. gives the principal results for each day relating to this first portion of the experiment.

Period of Discharge.

The discharge occupied 10h. 39m. and was effected in two operations, January 7 and 9; it was caused to traverse, as stated above, 11 Maxim lamps in a shunt circuit. The experiment began with 30 cells only. At the end of 6 hours two new cells were added; about two hours after, and during a quarter of an hour only, the remaining three cells were added. The current then had an intensity higher than that usually employed for the lamps. The operation of discharging was stopped on the first day of the experiment after it had lasted 7h. 15m., and was only recommenced two days after; at the end of 2h. 30m. after recommencing the operation of discharging the battery returned to its initial state. Nevertheless, the experiment was continued, but the quantity of electricity and the corresponding work, in this latter period, are not given in Table I., which gives the result of the observations during the normal discharge.

TABLE I.—*Data referring to the Charging of the Battery.*

Date and Duration of Experiments. 1	Mean Speed of Magneto-Electric Machine in Revolutions per min. 2	Mechanical work indicated by the Dynamometer in kilogram-metres. 3	Mean Potential of the Battery in volts. 4	Mean Intensity of the Charging Current in amperes. 5	Mean Intensity of the Exciting Current in amperes. 6	Quantity of Electricity Supplied to the Battery in coulombs. 7	Electrical Work of the Charge in kilogram-metres. 8	Electrical Work of Excitation in kilogram-metres. 9	Electrical Work of the Armature in kilogram-metres. 10
H. M.									
4 Jan....5 30	1 079	2 414 907	82·21	10·93	2·46	216·400	1 814 600	408 400	94 400
5 Jan....7 0	1 072	2 772 292	91·08	7·97	2·81	200·800	1 947 100	676 300	79 100
6 Jan....7 30	1 083	3 246 871	92·91	7·94	2·83	214·300	2 028 800	596 100	76 800
7 Jan....2 45	1 085	1 135 728	92·06	6·36	2·18	63·000	591 600	202 800	19 500
22 45		T=9 569 798 t= 808 750				694 500	T′= 6 392 100	T″ = 1 883 600	T‴ = 269 800
		8 761 048							

Electrical Readings.

The calculations of the electrical measurements were carried out as already described. Here is, amongst others, the calculation relating to the total expenditure of electricity:—

Date.	Mean Intensity.	Seconds.	Coulombs.
7th January	16·128	26 340	424 800
9th ,, ...	16·235	12 000	194 800
			619 600

The condition of the battery will be understood from the following:—

	E.M.F. of the 33 cells open, in volts.		Apparent Resistance of Battery in Ohms.	
	Initial.	Final.	Initial.	Final.
7th January ...	75·01	,, ...	·21	1·25
9th ,, ...	72·50	72·00	·26	1·41

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Resistance of the Lamps.

If we call r the resistance of the external circuit during the discharge, we have

$$e = E - RI = rI,$$

which enables us to calculate the value of r, since that of e and I is given at each period by observation. The circuit was closed by eleven Maxim lamps placed in a shunt circuit, the mean resistance of these lamps, cold, being 74 ohms. The intensity of the current varied from 1 to 1·65 amperes per lamp. The variation in the resistance presented the same features of increase and decrease as we shall notice presently in dealing with the decrease in the luminous intensity.

Photometric Readings.

During the whole time in which the normal discharge of the battery lasted it kept alight 11 Maxim lamps, the luminous intensity of which varied from 1 to 2 carcels, the mean being 1·40; this is equivalent to 10 hours 39 minutes × 1·40 = 13 hours 30 minutes of 11 carcels, or the light of 149·1 carcels during 1 hour. The total electrical work developed by the battery amounted to 3,809,000 kilogrammetres, each carcel per hour having cost $\frac{3,809,000}{149·1} = 28,820$ kilogrammetres, or 8 kilogrammetres per second. One h.-p. of electrical work would suffice to easily supply the number of lamps requisite to produce a continuous light of from 9 to 10 carcels.

We give below some readings which have been selected from amongst the extremes. It is not necessary to lay too much stress on the last, since the lamps were much below their normal standard:—

Hours of Observations.	E.M.F. Volts.	Intensity of Current. Amperes.	Elec. Work.	Work per Lamp.	Photometric Intensity.	Work per Carcel.	Carcels per horse-power.
H. M.							
2 43	61	16·37	101·75	9·25	1·43	6·47	11·59
12 45	59·5	15·94	96·84	8·80	1·72	5·12	14·65
4 0	44·9	11·49	52·62	4·78	·21	22·76	3·29

Resumé of the Period of Discharge.

The discharge was effected in two different operations on the 7th and 9th January, and lasted altogether 10 hours 39 minutes. The principal data in connection with the discharge are given in the following table:—

TABLE II.

Date and length of experiment.		Mean potential of battery in volts.	Mean resistance of current in ohms.	Quantity of electricity in coulombs.	External electrical work in kilogrammetres.
	H. M.				
7 Jan.	7 19	61·39	16·128	424·800	2,608·000
9 Jan.	3 20	61·68	16·235	194·800	1,204,000
	10 39			619·600	3,809·000

Conclusions.

In the first place we notice that between the quantity of electricity sent into the battery, 694,500 coulombs, and that which was obtained from it, 619,600, there is only a difference of 79,900 coulombs, equivalent to a proportional loss of about 10 per cent. (·108).

The external electrical work, during the entire period of discharge, reached 3,809,000 kilog.; the mechanical work expended was 9,570,000 kilog., but of this actual work supplied only 6,382,000 kilog. were able to be stored in the battery. From this it results that the work rendered during the discharge is represented by

3,809,000 : 9,570,000 = ·40 of total work

and 3,810,000 : 6,382,000 = ·60 of work stored.

This result explains why the quantity of electricity remained much the same in the two cases, where the discharge was made with a mean potential of $\frac{63,382,000}{695,300} = 91$ volts, and with a mean potential of $\frac{3,809,000}{619,600} = 61·5$ volts. In the two cases the levels were in the relation of 3 to 2. This difference of potential in the two distinct phases is inevitable. Suppose we represent the E.M.F. of the battery by I, its internal resistance by R, the intensity and duration of the current by I and t, during the charge, and suppose we represent the corresponding elements of the discharge by the same letters with the addition of dashes, the electrical result is expressed by

$$a = \frac{I'(E' - R'I')\,t'}{I(E - RI)\,t}.$$

Thus we have, after simplifying, $I'T' = IT$, and we may also take $E = E'$, which gives us

$$a = \frac{E - R'I'}{E + RI}.$$

We thus see that the result is always lower than unity, but as much greater as the intensities and resistances are smaller. It is well, therefore, to charge the battery with as weak a current as possible, and, consequently, to prolong the period of charging. In the actual experiment, E being nearly 75 volts, R′ I′ was found to be sensibly equal to R I, though I′ was greater than I. This would tend to show that the resistance of the battery was sensibly weaker during the discharge than during the charge.

To sum up, and to combine these results in a more comprehensible shape, the charging of the battery necessitated the expenditure of mechanical work to the extent of 1,558 horse-power during 22 hours 45 minutes = 1,365 minutes, or one horse-power during 1,558 × 1,365 minutes = 2,126 minutes, or 35 hours 26 minutes. The battery only stored in reality ·66 of this work, the surplus having been used up in resistances and in the work of exciting.

The work of 6,382,100 kilogrammetres thus stored was only returned externally to the extent of 60 per cent., and we may suppose that this proportion would have remained the same for any work other than, and analogous to, the keeping alight of the Maxim lamps, for which it was utilised.

The use of the accumulator, therefore, wasted 40 per cent. of the work furnished by the dynamo electric machine producing the current, or, in other words, 40 per cent. of work which could have been utilised but for its intervention. It is but just to add that against this waste must be placed the advantages to be derived in many cases from having stored up close to hand, and entirely at command, such a large reservoir of electricity.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

On Thursday, 13th inst., at the meeting of this society, Mr. F. HIGGINS, member, read a paper on a new form of battery of low resistance, which he exhibited in action during the evening. The novel feature of Mr. Higgins's battery is the maintenance of a continual flow of the solution throughout the series by the action of gravitation. The cells are of stoneware, fitted with an overflow spout, and are arranged on ascending stages one behind the other, so that the spout of the one vessel just overlaps the rim of the vessel below. A reservoir containing the solution surmounts the whole, and the taps, or spouts, are so regulated that a uniform flow —usually about ten drops a minute—is kept up in and out of all the vessels. The same liquid may be returned to the reservoir, and used again and again so long as the characteristic colour of bichromate solution continues unchanged. The economy of this battery was very remarkable, the waste products of bichromate batteries being utilised, and the mercury being recovered in an almost pure state. Besides this, its low internal resistance admirably fitted it for use on telegraph lines. Eighteen of these cells had been working nine permanent current Morse circuits, and had replaced no fewer than 250 Daniell cells with which the circuits were previously worked. The potential of each cell was nearly two volts. As showing their constancy, Mr. Higgins stated that a few of these cells had maintained a platinum irridium wire at a uniform red heat during six weeks. Two of the cells exhibited were made to work twelve electro magnets joined in multiple arc; and the loud beats of the armatures showed that there was plenty of power to spare. A wire was also maintained at red heat by means of six cells.

Mr. ANDREW JAMIESON then at considerable length brought to the notice of the Society the results of experimental tests made by him on various electric incandescent lamps. Diagrams showing the connections used, with rules for testing, elaborate tables giving the ratio of candle-power to work done in such lamps, together with the results of special tests of the Swan lamps in the months of February and March last, illustrated the discourse. The uniform conclusion arrived at from these tests was that the resistance of the carbon filament fell proportionately with the increase of the E.M.F. introduced.

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THE ELECTRICIAN.

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All communications to be addressed to 396, *Strand, London, W.C.*

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THE ELECTRIC LIGHTING BILL.

The development of the electric light has hitherto been made under great and increasing difficulties. When, some five years ago, it was described as the light of the future, the statement was generally regarded as the too sanguine opinion of certain scientific men. Its opponents looked upon it as an amusing but costly scientific toy. Then came the Paris Exhibition, which proved to many that the possibilities of the electric light had not been underrated. Unfortunately, owing to the crass ignorance of writers in the political papers, and the cuteness of those engaged in Stock Exchange transactions, a gas scare was managed, which scare proved almost disastrous to the electric light. We say almost disastrous, because these money transactions caused a large number of people to look at the electric light as a mere word to conjure with.

There has been, and is, a persistent and consistent attempt to put the question of cost, for example, in a way that, were it carefully considered, would be seen to be fallacious. What would be thought of a body of men interested in copying MSS., who attempted to prove the costliness of printing by basing their figures on the cost of one copy of a paper or a book? It is well known that the cost of the first copy of a book is altogether another matter from the cost of one copy out of ten or a hundred thousand; and so it is with the electric light. The cost of the small experiments that have been made bear little or no comparison with the cost of the light on a scale commensurate with that by which gas is distributed. The electric light has fought through the early difficulties, it has proved itself worthy of trial, and has demanded the removal of disabilities which hamper its distribution. Why should a gas company be allowed to lay down mains and an electric light company be refused? The electric light companies do not seek favours, all they ask is for the same facilities as gas companies. The future will prove the merits of the light. If it is not what is required, then assuredly it is doomed to gradual extinction. Companies are formed on business principles, they are expected to pay their shareholders a dividend, and if they do not, the Bankruptcy Court will eventually be their abiding place.

Mr. Chamberlain and Mr. Ashley have brought in a short Bill for the purpose we have sketched out, which has been read a second time and referred to a hybrid committee of fifteen members, nine selected by the House of Commons and six by the Committee of Selection. This Bill is in the right direction, and, although we might suggest alterations in several directions, we think we shall be consulting the interests of all concerned in electric lighting in reserving any criticism. It will undoubtedly undergo some few modifications before it finally passes. What we want is to see a Bill passed. We gather that this is also the case with the electric light companies, as may be seen from Mr. Crompton's letter in the *Pall Mall Gazette* of April 17, wherein he says:—"If under all the existing disadvantages the electric light can be supplied at a figure very slightly in advance of gas, there is little doubt that, with greater legislative facilities giving to the electric light companies the power of supplying private consumers, the cost of the public lighting will be very materially reduced." Replying to a previous correspondent as to cost Mr. Crompton in the same letter remarks:—"Your correspondent will soon have his doubts as to the cost of electric light removed, and, unless I am mistaken, will learn that in brilliancy, equal diffusion, trustworthiness, and economy, electricity far surpasses gas as an illuminating agent."

The correspondence which has passed between the Corporation of Manchester and the Board of Trade shows pretty clearly the ideas of the framers of the Bill:—

The corporation submit that, in accordance with the Report of the Select Committee of 1879, every local authority should be invested with the exclusive right within its own jurisdiction of supplying electricity for public and private purposes, and that the area of supply should in every case be co-extensive with such jurisdiction. They stated that there is nothing on the face of the bill to prevent several private electric companies from at once promoting provisional orders for the supply of electric lighting in the City of Manchester, whereby they would acquire the powers for breaking up streets conferred by the Gas Clauses Acts. The corporation, while urging that the powers of the Bill should in the first instance be confined, as already stated, to municipal corporations and local authorities, are also willing that means be provided, as suggested in the Report of 1879, for preventing undue inaction in the use of such powers, and urge that the true position of electrical patentees is to make contracts with local bodies.

The reply to this letter from the Board of Trade states that the report of that Committee of 1879 does not recommend that an exclusive right to supply electricity should be given to municipal authorities, but that "municipal authorities should have power to give facilities to companies or private individuals to conduct experiments," and that "when the progress of invention brings a demand for facilities to transmit electricity as a source of power and light from a common centre, for manufacturing and domestic purposes, it may be expedient to give to the municipal authority a preference during a limited period to control the distribution and use of the electric light; and, failing their

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acceptance of such a preference, that any monopoly given to a private company should be restricted to the short period required to remunerate them for the undertaking, with a reversionary right in the municipal authority to purchase the plant and machinery on easy terms." The Bill proceeds strictly on these lines. It enables the Board of Trade to grant either to a municipal body or to a private company a license for the use of electricity for five years (with a power of renewal at the end of that time); but in the event of a grant to a private company no such license will be granted without the consent of the local authority. The local authority will, therefore, always be able either to obtain such a license itself or to control and impose conditions on the grant of any such license to a private company. In the present state of knowledge it seems probable that this provision will in general be sufficient. The great object at the present moment is to facilitate and encourage the making of experiments, rather than to establish permanent schemes for lighting a whole town, and these experiments can best be made by limited supplies from numerous centres and within small areas. If, therefore, the criticism of the Manchester Corporation may be regarded as the worst that can be said of the Bill now before the House of Commons, we may reasonably hope and expect that the measure will pass this Session.

CORRESPONDENCE.

THE SELLON SECONDARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Under the heading of the "Sellon Secondary Battery" two letters appear in your issue of the 15th inst.

The object of the first, from the President of La Société la Force et la Lumière, must be sufficiently obvious to all. Under the guise of private correspondence, which he publishes before he can receive any answer, he makes statements, evidently in order to prejudice the public mind, which, so far as my knowledge goes, are absolutely without foundation. In my reply I give my view that the law courts form the only arena in which such matters can be satisfactorily dealt with, and I deprecate the appearance in print of such correspondence in anticipation of legal proceedings.

The letter bearing the signature of Mr. Faure raises altogether a different issue. In reply, I would only suggest that he should at once prepare the proof of his assertions, for they will most assuredly be required.

I leave it to the common sense of those who take an interest in this discussion, whether, had Mr. Faure been able at the dates mentioned to have so constructed his batteries as to avoid the difficulties and failures which, up to the present moment, have, in the opinion of most scientific men, been inherent to them, would he not have done so?

It seems to me that the points of general interest are as under, and that no further discussion can be of use until they are settled:—

1st. Are the batteries constructed by the Electrical Power Storage Company of the superiority over the "Faure," which is claimed for them?

2nd. If so, are the points which bring about this result protected by patents, and are these patents the property of the Company?

3rd. Are they in any degree tributary to any valid claims of the Faure lamp?

4th. Are the "Faure" plates as recently constructed tributary to the Sellon-Volckman claims?

Why any personal ill-feeling is to be imported into the determination of these points is a mystery to me. For one inventor to be after another in his ideas is no disgrace—it is only his misfortune. The only ground for ill-feeling which occurs to me would be on the part of any of the public if they have through misrepresentation been induced to embark money in either undertaking.

I may mention that the Electrical Power Storage Company is now taking steps to have the above-referred-to four points determined scientifically and legally. We have already proposed to the English "Faure" Company a reciprocal examination of the respective batteries as shown at the Crystal Palace, but as yet without response, and I will only ask your readers to suspend all judgment until full and definite decisions have been arrived at.

Meanwhile, as soon as the manufacture on the large scale being prepared for is sufficiently advanced, the new batteries will be offered to the public under guarantee of indemnity against any action on the part of the "Faure" Company.—Yours, &c.,

JOHN S. SELLON.

Ilfracombe, 19th April, 1882.

THE SELLON v. FAURE ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Being an independent observer, and taking a great interest in the conversion of electrical energy or storage of electricity, I beg to say a few words in reference to the Sellon and Faure accumulators. If we carry our minds back to the *début* of the Faure accumulator the announcement of the two million foot pounds of energy in the celebrated box of electricity or condensed lightning so graphically described in *The Times* of May 16 last, which was carried from Paris to Glasgow for examination by Sir W. Thomson, such announcements naturally caused a desire on the part of those having an electrical knowledge to procure one of these wonderful cells. I, like many others, had a great desire to obtain one or two cells, and after having made two or three calls at the office of the Société Anonyme La Force et la Lumière in the Strand was unable to buy a cell. Being thus defeated I set to work (after reading all published descriptions of the constructions of these batteries) and made three cells, with which I made many experiments with very fair results. Referring to the construction of a Faure accumulator, the main feature of the invention appears to be in covering the *surface* of sheet lead with minium or other oxides of lead, enveloping the plates in parchment, felt, or other suitable material, so as to keep the oxides on and in contact with the plates. This arrangement is, of course, an improvement on M. Planté's mode of making secondary batteries. He (M. Planté) in the year 1859, taking advantage of the great affinity of peroxide of lead for hydrogen, made use of this substance to increase the effects of secondary batteries. I have not read or heard of any Faure batteries in which perforated lead plates were used, and the parchment, felt, or other supports for the oxides dispensed with. The Sellon accumulator is, I think, without a doubt, an improvement on the Faure, as it entirely does away with felt or any packing, thereby reducing the resistance to a minimum. Another difference, the surface of the plates are not used to contain the active material, which is not minium or an oxide of lead. The form of construction is certainly very different to any form of Faure cell I have at present heard of. In my opinion, M. Planté would be quite justified in claiming the improvements of M. Faure, or at least as much so as M. Faure is in claiming the improvements of M. Sellon. The difference in form and the superior results obtained in storage capacity, durability, and simplicity in construction are, I think, a plain proof that M. Faure has never adapted this form of cell.—Yours, &c.,

H. A. KENT.

THE SELLON SECONDARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Most of your readers who have followed the reports and letters which have lately appeared in your pages on the subject of the rival secondary batteries will be surprised to hear (what, however, is the fact) that the patents of Messrs. Faure, Swan, and Sellon were all taken out by one and the same patent agent, as they will probably suppose that a patent agent would dissuade one client from patenting an

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article so similar to something already patented by another client that a microscopical inspection is necessary in order to discover any difference between them. Those, however, who may have formed such an opinion must take an extremely optimist view of human nature, as such is the greed of gain that the temptation to advance one's personal pecuniary interests under such circumstances is usually too strong to be resisted, and hence a number of patents are taken out which ought never to have existed, and much costly litigation is the consequence. The moral to be drawn from these facts is that rival inventors and would-be patentees should take independent legal advice, as it is difficult to see how one man can act as a faithful counseller where various conflicting interests are involved. Patentees themselves, however, are not altogether blameless in this matter, as they frequently avoid a man who will give them an honest, unbiassed opinion on their alleged inventions, and prefer to have their *amour propre* flattered, even although it may ultimately be at the expense of their pocket.—Yours, &c.,

April 17th. VIGILANCE.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having read the letter published by Mr. C. A. Faure, respecting perforated plates, we think it advisable to state that, having successfully carried out some experiments for transmission of power by means of a small electric motor 2ft. by 1ft. 6in., 6in. high, from which we obtained 3·97 h.-p., we constructed various secondary batteries with the object of obtaining the largest acting area in the smallest space, and early in 1881 we made special machinery for this purpose for rolling corrugated plates. One of the objects was to utilise a metal that would occlude gases. Hydrogen and iron were used for this purpose, also antimony; but what we wish to state is that we used perforated thin iron plates, which led to our using perforated lead plates in various forms, and for which patents have been taken out. This renders all kinds of felt, parchment, and other similar insulating material unnecessary. Lead, in the form of shot of various sizes, was experimented with. We believe our method secures an active area of three to two as compared with the previous methods employed, and also an equal advantage in weight of material. We hope to send you shortly an account of our system as applied for the substitution of horses, in coal and other mining operations.—Yours, &c., ELECTRIC BLASTING APPARATUS COMPANY.

Cinderford, April 18th, 1882.

EARTH CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whether it be that our friends across Channel have made an attempt to fire the Shannon, or whether it be in consequence of an exceptionally prominent display of sun-spot or moonshine, it is hard to determine; but whatever it may have been that has influenced the electrical condition of our globe, certain it is that we have just experienced the effects of an electric storm such as practical electricians have the good fortune rarely to meet.

As with storms generally, so this burst suddenly upon the United Kingdom, without gradation or warning, at about 2 a.m. to-day, and currents of great strength passed to and from in a direction apparently N.W. and S.E. These lasted down to 6 a.m., when a subsidence took place, followed, however, by a further display at 9 a.m.

Very curiously from this time, instead of maintaining something of a given directive influence, the storm seemed to split up into eddies embracing certain districts, the currents being not only strong, but at "sixes and sevens," presenting remarkable vagaries from 11 a.m. to 2:30 p.m., at which time the forces gradually weakened. During the evening the currents again strengthened, but vanished as completely and almost as suddenly as they first appeared at about 8 p.m.

Many features of this storm were interesting, and, perhaps, instructive, and the question of causation is again brought prominently to the front. Atmospheric changes appear to bear no relationship to these storms—neither rain, cloud, nor sunshine. Moreover, careful comparison between barometric and thermometric changes and these natural currents offers nothing tangible.

Sun spots have been saddled with the production of electric storms, but my own records for several years warrant no such conclusion.

To my mind, it seems far more probable that such electric disturbances (phenomena altogether distinct from the normal earth current), are the result of comparatively local causes, and it may be that a better knowledge of the internal changes of our globe in relation to the moon's internal forces may yet reveal hidden truths bearing upon some of these natural mysteries.

At all events, we have yet to be furnished with evidence affirmative of sun spot causation.—Yours, &c.,

London, April 17, 1882. ALEX. J. S. ADAMS.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot allow the letter of Mr. Desmond FitzGerald to pass without comment.

Archimedes is reported to have said that he could move the earth if he could obtain a fulcrum. I have already shown in your pages and elsewhere that the FORCE of the sun is always acting upon the earth on the principle of a lever and an inclined plane. *This force acquires different names according to the phenomena elicited by its action upon matter.* It may be known as magnetism, electricity, light, heat, &c., but it is always the same *indestructible* force which has been transmitted to the earth from the sun—just as it has been imparted from some other luminary to the sun—and it then pervades every atom of terrestrial matter. It is well known that every atom of matter has a certain capacity and directive influence upon this force, and I have called attention to the fact in *The Electrician* that the magnetic properties vary with the capacity and resistance of matter for force.

When we still further recognise the fact that the animal body is built up of atoms of matter thus charged with force, that change of momentum is imparted to the force by each variation in the physical conditions, or relations of the atoms to contiguous atoms; that the magnetic states of arterial and venous bloods differ; that physical life is maintained by the motion of the comparatively highly magnetic arterial blood corpuscle; that the activity of the functions of life are in exact proportion to the degree of these magnetic properties; that the venous blood—in which by an admirable provision of Nature the power of radiating force has been temporarily diminished—is incapable of sustaining life; and further still, that the cells of which an animal body is composed are built up under the same description of centripetal and centrifugal force which is engaged in causing the rotation of the earth and the celestial bodies in general, together with a host of other physical laws too numerous even to enumerate in such a letter as the present, it does seem strange that the physicist can doubt the influence electricity and magnetism are capable of exerting upon the living body as therapeutic agents.

For some years past I have employed these forms of the force with, I believe, the most marked results.

To get rid of the trade aspect of the question I have had my magnetic appliances made for me upon my own principle by a very intelligent chemist of this town, who provides them at a cost to recuperate himself and the trade.

Surely, if the powers of the tissues have been weakened, or, in other words, if the component elements are other than natural, or have been more loosely combined than in a state of health, then the resistance to the transit of force and the phenomena resulting therefrom from physical causes must vary correspondingly.

There can be no question but that each tissue, be it bone, muscle, or nerve, &c., selects from the blood the necessary materials for its own composition by virtue of the law by which every form of matter transmits force in distinct and well-defined lines.

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Under such circumstances it is difficult to imagine any more scientific method of adding to the enfeebled powers or material structure of a part than by adding to that force which tends at one and the same time to the aggregation of the necessary elements, to the conversion of such elements into healthy cells, and to the elimination of all kinds of matter that could act as impurities.

It is admitted on all sides that up to the present time our system of therapeutics is loose in the extreme, and, indeed, has ever been regulated by the experience gained by the action of certain substances. I venture to predict that in a very near future we shall base our therapeutics upon the well-defined laws of matter and force, and that electricity and magnetism will play a most important part in preserving the health of the community as well as in the treatment of disease.—Yours, &c.,

RICHARD C. SHETTLE, M.D.

Reading, April 3rd, 1882.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your preceding number Dr. Shettle refers me to the papers he has yet to write on magnetism for a reply concerning the nature of electricity, but while doing so, he reaserts "that electricity is not a *peculiar kind of matter*, but a peculiar *condition of matter*, which is brought about by the action of the sun upon the earth, and that *such condition is common to all matter*, although the electric force, like the magnetic, is capable of being manifested in much greater degree by some forms of matter than others." Seeing that Dr. Shettle has thus plainly stated what he is going to try to establish by his writings, I do not see any necessity for waiting till he has written any more on the subject, and that for the following reasons:

First. He writes that "he believes there is ample evidence to prove that electricity is not a *peculiar kind of matter*." Now, I ask him to produce one well attested fact which proves that electricity is not a *peculiar kind of matter*. In looking for this proof let him keep in mind that magnetism is a compound result of electric matter and common matter, and that any proof must be from phenomena simply electrical, and not the compound called magnetism.

Second. In *The Electrician* of the 11th of March, page 271, I drew Dr. Shettle's attention to the electricity which is invisible and scattered over the surface of an insulated sphere until an uninsulated conductor is brought near to the insulated sphere. Then the scattered invisible electricity on the sphere instantly rushes together and forms the body called a spark, and this spark afterwards disrupts the air, leaping through it to the uninsulated conductor. The rushing together of the scattered invisible electricity to form the visible body called a spark is a demonstration that electricity *is a peculiar kind of matter;* for the rushing together of the invisible electricity can arise from no other cause than that of attraction within its own particles. I ask Dr. Shettle to show, if he can, that I am wrong in this conclusion. Will Dr. Shettle maintain that upon the invisible electricity rushing together to form the visible spark is "a product of the action of the sun producing a peculiar condition of matter."

While I have pen in hand, allow me to notice one good result which has arisen from the correspondence in *The Electrician*. In the *Saturday Review* of 25th of February last there are some critical remarks on Professor S. P. Thompson's first lecture on electricity in the Crystal Palace. The critic states that Professor Thompson said that he "looked upon a postive charge as a condensation of ether; on a negative charge as a rarefaction of ether; and on an electric current as a flow of ether." If the foregoing is a correct report, it is a great improvement upon Professor Thompson's former opinion, that "electricity was neither matter nor energy."—Yours, &c.,

JAMES JOHNSTONE.

Experiment Rooms, 1, James-square,
Edinburgh, 17th April, 1882

PUBLISHED EXPERIMENTS AND RESULTS OF ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following table has been compiled from results published in various papers and books. It is to be regretted that, although photometric measurement is still in an unsatisfactory state, it is very difficult to learn the "duty" of the various systems.

Lamp.	Maker of Dynamo.	Authority.	H.P.	No. of Lights	Candle-power each.	Per H.-P.	Total candle-power.	Candles per H.-P.	Cost each per hour.	Remarks.
Swan	.....	Professor Adams in	.....	.....	60		.....	448		
Do.	Brush	Cantor Lectures	16	70	66	4·38	4,200	2625		
Do.	Birgin	Do.	6	48	48	8	2,304	384		
Do.	Gramme	Savoy Theatre	5 or 6	25	45	5 or 4	1,125	200	1 1-9d.	Gas at 3s. 6d., ditto for 2d. (A. S.)
Do.	Siemens	Maxim	120	1200	20 (?)	10	24,000 (?)	200 (?)		90 ohms, 45 volts.
Maxim	.....	Adams	8	100	.....	40	4,000	500		1·6 ampere, 45 volts.
Do.	.....	.....	.....	.....	.....	75	.....	403		
Lane Fox	.....	Do.	.....	.....	.....	15	.....	150		46 ohms, 58 volts.
Edison	.....	Do.	.....	.....	.....	13·16	.....	116		125 ohms, 110 volts.
Werdermann or Joel	.....	Do.	.....	.....	.....	320	.....	779		= gas at 4s. (A. S.)
Do.	.....	Do.	9 or 10	10	320		3,200	320	5d.	
Do.	.....	A. Siemens	1	1	6,000		6,000	6,000	1½d.	
Brush	.....	Do.	5 (?)	15	400		6,000	1,200 (?)		2s. 1d. for the 15.
Do.	.....	Brush	13·78	16	6,000		96,000	690		800 volts.
Do.	.....	Du Moncel	3·28	.....	.....		1,230	377		
Do.	.....	Do.	3·76	.....	900		900	239		
Siemens	.....	Adams	1	2	400		800	800		Gas ditto 8d. (A. S.)
Do.	.....	Du Moncel	3·3	.....	.....		6,864	2,080		
Do.	.....	Do.	3·5	.....	.....		5,539	1,582		
Do.	.....	Do.	6·6	.....	.....		14,134	2,141		
Do.	.....	Do.	9·8	.....	.....		14,818	1,512		
Siemens	.....	Urquhart*	18	4	4,000		18,800	1,175	6s.	Carbons 2s. 8d.
Do.	.....	A. Siemens*	.....	7	400					
Do.	Gramme	Du Moncel	1·84	1	4,000		705	383	12·05d.	Carbons 5·5d.
Do.	.....	Do.	5·3	.....	.....		6,663	1,257		
Do.	.....	Do.	10·5	.....	.....		11,396	1,085		
Jablochkoff	.....	Met. Board of Works.	13·17	5	.....		1,395	106·2		
Do.	.....	Do.	17·19	10	279 naked		2,790	156·0		
Do.	.....	Do.	20·75	15	195 ground		4,186	202·0		
Do.	.....	Do.	23·53	20	165 opal		5,580	236·0		
Lontin	.....	Urquhart†	‡	6	480		2,880	.....	5½d.	Carbons 8d., coal 1s. 2d.

(A. S.) refers to Mr. Alex. Siemens' paper. In each case ..... signifies that no information was given under this head. * British Museum. † St. Lazarre Station. ‡ 9½-inch by 13½-inch cylinder.

Many of these results are now getting old, and it is to be hoped that the makers will come forward with their latest measurements.—Yours, &c.,

Ironworks, Erith, Kent. ALEX. P. TROTTER.

GLASS GLOBES FOR ELECTRIC LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Being one of your readers, I hope you will, when possible, procure me some addresses of *glass globe* manu-

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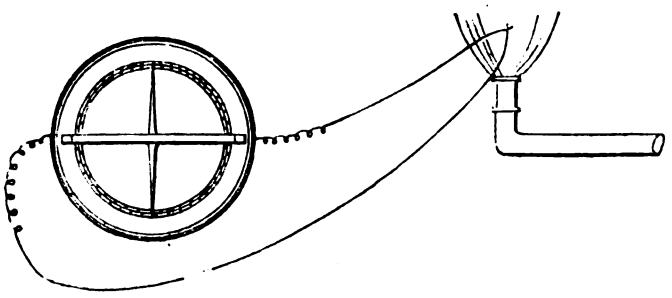
facturers for electric lamps. Waiting for the favour of your answer.—Yours, &c., W. Smit, Johz.

Slikkerveer (bij Rotterdam), 14th April, 1882.

THERMO-ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Whilst performing some experiments relating to thermo-electricity I found that if a piece of copper wire, say four feet long, be taken and divided into two equal portions, so as to ensure practical density in the two pieces, and one end of each connected to an astatic galvanometer, the free ends being crossed and heated in a gas flame, and



then caused to make and break contact, that at each time this was done a deflection of the galvanometer took place.

By further experiments of a similar character I found that I could obtain a permanent deflection so long as the wires were in contact and the gas flame burning fairly constant.

Perhaps some of your readers will kindly explain the reason of the above phenomena.—Yours, &c., E. E. A.

April 18, 1882.

THE PHOTOPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In all that has been written on the Photophone as a telegraphic instrument I have not yet seen any allusion to a passage in Moigno's *Traité de Télégraphie Electrique* (p. 10, 2nd edition), which is curiously *apropos* of the subject. I translate the passage for the benefit of your readers—

"Another means of producing, at great distances, a momentary impression without an artificial conductor is furnished by radiant heat, which, acting by the aid of a converse mirror on a thermo-electric pile, gives rise to galvanic currents, which, in their turn, produce deviations of the magnetic needle. The difficulties of installing such an apparatus are doubtless great, but perhaps not insurmountable. Such a telegraph would have over the optical (luminous) telegraph the advantage of not requiring the constant presence and attention of the observer, but clouds and other atmospheric effects would often prevent its action, and that is a great (*capital*) defect, which, joined to the embarrassments it would entail, will never permit it receiving the preference, nay, not even the favour of a trial."

Even the photophone may be said to have its foreshadowing in this passage. Indeed, I have come to the conclusion, after a long course of reading in musty tomes, that there is nothing new in telegraphy, as I hope to show some day.

Shiraz, Persia, 10th March, 1882. J. J. Fahie.

PUBLICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you kindly inform me in your next issue if there is a serial publication describing the mechanical construction of electric machinery and apparatus, and giving all the newest inventions in detail? If there is such a work, can you give the name, please?—Yours, &c., A. M. Grist.

[We think the information you require is to be found in our pages better than in any other serial publication. At any rate, we endeavour to describe and illustrate the new inventions that commend themselves to us as containing something original and good. Our contemporaries, the *Engineer* and *Engineering* also describe and illustrate electrical apparatus, and especially electric light machinery.—[Ed. *E.*]

[*** Owing to pressure on our space, we have to leave out several interesting letters.]

THE ELECTRIC LIGHTING OF THE CITY OF LONDON.

Preliminary Report by the Corporation Engineer.

At the meeting of the Commissioners of Sewers of the City of London on Tuesday, the 21st ult., a report on the contracts for electric lighting was presented by Mr. W. Haywood, the engineer and surveyor for the City. It was ordered —"That the said report of the engineer be printed and circulated as usual;" and this has just been done. The report, dated February 24, 1882, addressed to the Streets Committee, reads as follows:—

As the contracts for the experiment in lighting by electricity some of the main thoroughfares in the City expire on the 31st March, I beg to lay before you some facts relating to it, to assist you in determining as to the continuation or extension of the experiment.

The electric lighting is divided into three districts, as follows:—District No. 1 includes Blackfriars Bridge, New Bridge-street, Ludgate-circus, Ludgate-hill, St. Paul's-churchyard (north side), and Cheapside (from its western end to King-street): the length of thoroughfare being about 1,648 yards. District No. 2 includes Southwark Bridge, Queen Victoria-street, Queen-street (between Queen Victoria-street and Upper Thames-street), and Queen-street-place; the total length of thoroughfare being about 1,703 yards. District No. 3 includes London Bridge, Queen-street (between Queen Victoria-street and Cheapside), Cheapside (between King-street and Poultry), King-street, Guildhall-yard, Poultry, Mansion House-street, Royal Exchange (open space in front of), King William-street and Adelaide-place; the total length of thoroughfares being about 1,521 yards.

On October, 28th, 1880, tenders were received from four contractors, from which the following were selected, viz.:—

For District No. 1.—The Anglo-American Light Company (Brush system), at a cost of £1,410.

For District No. 2.—The Electric and Magnetic Company (Jablochkoff system), at a cost of £2,930.

For District No. 3.—Messrs. Siemens Brothers, at a cost of £3,720. The total cost being £8,060.

[In District No. 2 the Electric and Magnetic Company (Jablochkoff) having failed to enter into a contract it was assigned to the Electric Light and Power Generator Company (Lontin system), upon the same conditions and cost as the Jablochkoff.]

These amounts include the cost of laying the conductors, erecting the posts, lamps, and everything requisite for the lighting, as well as for lighting the districts for twelve months. The amounts separately are as follow:—

	For Works.	Lighting for 12 Months, Sunset to Sunrise.	Total Cost for 12 Months.
District No. 1 (Brush system)	£750	£660	£1,410
District No. 2 (Lontin system)	1,470	1,460	2,930
District No. 3 (Siemens)	1,450	2,270	3,720
Totals	£3,670	£4,390	£8,060

In Districts No. 1 (Brush) and No. 3 (Siemens) the electric lighting was in operation on the 1st of April last, and has been continued ever since. In District No. 2 (Lontin) the lighting was to have been commenced on the 1st of June; but it has not yet been perfected. The Company has, however, for many months past lighted its lamps generally during the hours of the greatest traffic, and at its own expense; but as it has not taken upon itself the entire

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responsibility of lighting the public ways, and the gas lamps have not been dispensed with, it has not yet lighted the district according to the terms of its contract. The Company states that it expects to complete the lighting very shortly.

The number of electric lamps in each district and their estimated illuminating power, *as stated by the various Companies*, is as follows :—

	Number of Electric Lamps.		Illuminating Power. Candles.
District No. 1 (Brush system)	33	... each	2,000
District No. 2 (Lontin system)	32	... „	1,000 to 1,500
District No. 3 (Siemens) ...	6 large lamps,	each	5,000
	28 small „	„	300

The gas lamps disused, and the cost of lighting and maintaining them for a year, according to the contract with the Gas Company for the year 1881, would have been as follow :—

	Approximate Number of Gas Lamps disused.		Approximate Cost of Gas Lighting.
District No. 1	156	.....	£690 about.
District No. 2	157	.....	700 „
District No. 3	139	.....	612 „

Dismissing the outlay for works, the cost of the electric lighting as compared with gas, assuming that all three companies had fulfilled their contracts, would have been as follows :—

	Cost of Gas Lighting, for 12 months, from Sunset to Sunrise, including Cleaning, Lighting, and Repairing Lamps.		Cost of Electric Lighting for 12 Months, from sunset to Sunrise, exclusive of Cost of Works.
District No. 1	£690	.....	£660
District No. 2	700	.....	1,460
District No. 3	612	.....	2,270
Total ...	£2,002	.....	£4,390

To the cost of the electric lighting must, however, be added that of cleaning and keeping in repair the disused gas lamps for a year, which will amount to about £350. Dismissing the expense of maintaining the disused gas lamps, the cost of the electric lighting in District No. 1 (Brush) would be about the same as that of gas; in No. 2 (Lontin) about twice the cost of gas; and in No. 3 (Siemens) $3\frac{3}{4}$ times as much as gas.

During the experiment many interruptions (as might have been expected) have taken place in the electric lighting, but as arrangements were made for lighting the gas lamps when they occurred, but little inconvenience was felt. The expense of this gas lighting will be borne by the Electric Lighting companies. The most serious interruptions are attributed by the companies to defects in their cables, and the smaller interruptions mostly to defect in the carbons. In District No. I (Brush) a long interruption occurred from the 2nd of May to the 13th of May inclusive, during which time none of the lamps were lighted. The interruptions since then have been comparatively few. In District No. 3 (Siemens) an interruption to a portion of the lighting took place from the 8th to the 12th of April, inclusive; it is stated to have arisen from the cable having been damaged by a barge. Since then there have been other defects, but for the most part short in duration, and attributable to defects in the carbons and machinery. No account has been kept of the lighting in District No. 2, the lighting, according to the contract terms, not having commenced.

No reference is here made to lighting the Holborn Viaduct by Edison's incandescent lamps, inasmuch as the experiment has not yet commenced.

The contracts terminate on the 31st of March, after which I propose to lay before the Commission a further report; and a detailed account of the whole of the interruptions to the lighting which have taken place throughout the year.

The figures in this report must be taken as approximate.

(Signed) WILLIAM HAYWOOD, Engineer and Surveyor.

A BILL TO FACILITATE AND REGULATE THE SUPPLY OF ELECTRICITY FOR LIGHTING AND OTHER PURPOSES IN GREAT BRITAIN AND IRELAND.

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :—

1. This Act may be cited for all purposes as the Electric Lighting Act, 1882.

2. The Board of Trade may from time to time license any local authority as defined by this Act, or any company or person, to supply electricity for any public or private purposes within any area, subject to the following provisions :—1. The consent of every local authority having jurisdiction within the area or any part of the area within which a supply is licensed to be furnished shall be required to the license. 2. A license shall be for any period not exceeding five years, but may, at the expiration of such license, be renewed at any time with such consent, as above mentioned, upon such terms and conditions as the Board of Trade may determine. 3. Public purposes shall mean lighting any street or any place belonging to or subject to the control of the local authority, or any church or registered place of public worship, or any vestry hall or building belonging to or subject to the control of any public authority, or any public theatre, but shall not include any other purpose to which electricity may be applied. 4. "Private purposes" shall include any purposes whatever to which electricity may, for the time being, be applicable, not being public purposes. 5. Where a supply of electricity is provided in any part of an area for private purposes, then, except in so far as is otherwise provided by the terms of the license, every person within that part of the area shall, on application, be entitled to a supply on the same terms on which any other person in such part of the area is entitled under similar circumstances to a corresponding supply; and the local authority, company, or person supplying such electricity shall not be entitled to prescribe any special form of lamp or burner to be used by any person, or in any way to control or interfere with the manner in which electricity supplied for private purposes is used. 6. The license may make such regulations as to the limits within which and the conditions under which a supply of electricity is to be compulsory or permissive, and for enforcing the performance by the licensees of their duties in relation to such supply, and generally may contain such regulations and conditions as the Board of Trade may think expedient.

Where in any area within the jurisdiction of a local authority any road is not repairable by such local authority, such road shall not be broken up without the consent of the authority or person by whom such road is repairable, unless in pursuance of special powers in that behalf inserted in the license, or with the written consent of the Board of Trade, and the Board of Trade shall not in any case insert such special powers or give such consent until notice has been given to such authority or person, and an opportunity has been given to such authority or person to state any objections they may have thereto.

3. The Board of Trade may, from time to time, by provisional order authorise any local authority, company, or person to supply electricity for any public or private purposes within any area, without requiring such consents as are required to the granting a license under this Act, and for such period, whether limited or unlimited, as the Board of Trade may think proper, but in all other respects subject to the like provisions as in the last section contained with respect to licenses, and subject also to the following provisions :—1. The Board of Trade may submit to Parliament for confirmation any provisional order granted by it in pursuance of this Act, but any such order shall be of no force whatever unless and until it is confirmed by Act of Parliament. 2. If, while the Bill confirming any such order is pending in either House of Parliament, a petition is presented against any order comprised therein, the Bill, so far as it relates to such order, may be referred to a select committee, and the petitioner shall be allowed to appear and oppose, as in the case of private bills. 3. Any Act confirming any provisional order granted in pursuance of this Act may, on the application of the local authority, company, or person thereby authorised to supply electricity, be repealed, altered, or amended by any subsequent provisional order granted by the Board of Trade and confirmed by Parliament. 4. Where any company or person is authorised by provisional order to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of seven years from the date of the passing of the Act confirming such provisional order, and within six months after the expiration of every subsequent period of seven years, by notice in writing require such company or person to sell, and

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thereupon such company or person shall sell to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale) of all lands, buildings, works, materials, and plant of such company or person suitable to and used by them for the purposes of their undertaking within such jurisdiction, such value to be in case of difference determined by arbitration. The Board of Trade may determine any other questions which may arise in relation to such purchase, and may fix the date from which such purchase is to take effect, and from and after the date so fixed, or such other date as may be agreed upon between the parties, the powers of such company or person in relation to the supply of electricity under this Act within such area or part thereof as aforesaid shall absolutely cease and determine, and shall vest in the local authority which has made the purchase.

4. The Board of Trade may from time to time make, and when made may rescind, alter, or repeal rules in relation to the applications for licenses or provisional orders, and to the payments to be made in respect thereof, and to any other matters arising under this Act.

Where a supply of electricity is authorised to be furnished under this Act in any area, the Board of Trade may from time to time themselves make, rescind, alter, or repeal, or authorise any local authority from time to time to make, rescind, alter, or repeal, byelaws for the protection of the public in relation to such supply, and to the insulation of the electricity or otherwise; and there may be annexed to any breach of such byelaws such penalties, to be recovered in a summary manner, as the Board of Trade may think necessary.

5. Any expenses incurred by a local authority in respect of any undertaking under this Act, and not otherwise provided for, including any expenses incurred in obtaining the license or provisional order authorising the undertaking, may be defrayed out of the local rate as defined in the schedule to this Act, and the local authority may from time to time cause such rates to be levied as may be necessary for the purpose of defraying such expenses; provided that where such local authority is a rural sanitary authority such expenses shall be deemed to be special expenses within the meaning of the Public Health Act, 1875.

6. A local authority authorised to supply electricity by any license or provisional order granted under this Act may from time to time borrow money on such security, with such consent and subject to such provisions and restrictions with respect to borrowing and the repayment of loans as are in the schedule to this Act in that behalf mentioned, and the money so borrowed shall be deemed to be borrowed under the enactments subject to the provisions and restrictions of which it is borrowed, and the accounts of all receipts and expenditure by the local authority in pursuance of this Act or any license or provisional order granted thereunder, shall be subject to such audit as is in the said schedule in that behalf mentioned.

Any moneys borrowed under this section by the local authority of any district to which the Local Loans Act, 1875, extends, may, if it is thought fit, be borrowed in manner provided by that Act; and in the construction of the said Act for the purposes of this Act, the expression "prescribed" means prescribed by any conditions imposed by the authority whose consent is required to borrowing under this section.

This section shall not apply to the mayor, commonalty, and citizens of the city of London or to the Metropolitan Board of Works except in so far as the Metropolitan Board of Works may be concerned in the borrowing of any money by any vestry or district board.

7. Any local authority, company, or person authorised to supply electricity by any license or provisional order under this Act (which local authority, company, or person are in this Act referred to as the undertakers) may, subject to and in accordance with the provisions and restrictions of this Act and of such license or provisional order, and for the purpose of supplying electricity, acquire such lands by agreement, construct such works, acquire such licenses for the use of any patented or protected processes, inventions, machinery, apparatus, methods, materials, or other things, enter into such contracts, and generally do all such acts and things as may be necessary and incidental to such supply.

8. The provisions of the following Acts shall be incorporated with this Act, that is to say: (1) The Lands Clauses Acts, except the enactments with respect to the purchase and taking of lands otherwise than by agreement, and except the enactments with respect to the entry upon lands by the promoters of the undertaking; and (2) the provisions of the Gasworks Clauses Act, 1847, with respect to breaking up streets for the purpose of laying pipes, and with respect to waste or misuse of gas or injury to the pipes or other works, except so much thereof as relates to the use of any burner other than such as has been provided or approved of by the undertakers; and (3) sections 38 to 42 inclusive, and sections 45 and 46, of the Gasworks Clauses Act, 1871.

In the construction of all the enactments incorporated by this section "the special Act" means this Act inclusive of any license or provisional order granted under this Act; and the "promoters" or "undertakers," and "the undertaking," as the case may be, mean the undertakers and the undertaking respectively under this Act.

In the construction of the said Lands Clauses Acts, "land" includes easements in or relating to lands.

In the construction of the said Gasworks Clauses Act. 1847, and the Gasworks Clauses Act, 1871, the said Acts shall be construed as if "gas" meant "electricity," and as if "pipe" meant electric line, and "works" meant "works" as defined by this Act, and as if "the limits of the special Act" meant the area within which the undertakers are authorised to supply electricity under any license or provisional order granted in pursuance of this Act.

All offences, forfeitures, and penalties under the said incorporated provisions of the said Acts or any of them may be prosecuted and may be recovered in manner by the said Acts respectively enacted in relation thereto provided that rents for electricity shall not be recovered as penalties, but may be recovered summarily as civil debts.

9. The undertakers may alter the position of any such pipes or wires being under any street or place authorised to be broken up by them as may interfere with the exercise of their powers under this Act, on previously making or securing such compensation to the owners of such pipes or wires, and on complying with such conditions as to the mode of making such alterations as may before the commencement of such alterations be agreed upon between the undertakers and owners, or in case of difference as may be determined in manner prescribed by the license or provisional order authorising the undertakers to supply electricity, or where no such manner is prescribed as may be determined by arbitration.

10. In the exercise of the powers given them under this Act or any license or provisional order granted thereunder, the undertakers shall cause as little detriment and inconvenience and do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason or in consequence of the exercise of such powers, the amount and application of such compensation in case of difference to be determined by arbitration.

11. The undertakers shall not, in making any agreements for a supply of electricity, show an undue preference to any person, but, save as aforesaid, they may make such charges for the supply of electricity, in this Act called "electricity rent," as may be agreed upon, not exceeding the limits of price imposed by or in pursuance of the license or provisional order authorising them to supply electricity.

12. Any person who unlawfully and maliciously cuts or injures any electric line or work with intent to cut off any supply of electricity shall be guilty of felony, and be liable to be kept in penal servitude for any term not exceeding five years, or to be imprisoned with or without hard labour for any term not exceeding two years; but nothing in this section shall exempt a person from any proceeding for any offence which is punishable under any other provision of this Act, or under any other Act, or at common law, so that no person be punished twice for the same offence.

13. Any person who fraudulently abstracts, causes to be wasted, consumes, or uses any electricity shall be guilty of simple larceny and punishable accordingly.

14. The undertakers shall not lay down any main or wire or do any other work for the supply of electricity whereby any telegraphic line of the Postmaster-General is or may be injuriously affected; and before any such main or wire is laid down or work is done within ten yards of any part of a telegraphic line of the Postmaster-General, the undertakers or their agents, not more than twenty-eight nor less than fourteen days before commencing such work, shall give written notice to the Postmaster-General specifying the course and nature of the work, including the gauge of any wire, and the undertakers and their agents shall conform with such reasonable requirements (either general or special) as may from time to time be made by the Postmaster-General for the purpose of preventing any telegraphic line of the Postmaster-General from being injuriously affected by the said work.

Any difference which arises between the Postmaster-General and the undertakers or their agents with respect to any requirements so made shall be determined by the Board of Trade.

In the event of any contravention of or wilful non-compliance with this section by the undertakers or their agents the undertakers shall be liable to a fine not exceeding ten pounds for every day during which such contravention or non-compliance continues, or if the telegraphic communication is wilfully inter-

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rupted, not exceeding fifty pounds for every day on which such interruption continues. Provided that nothing in this section shall subject the undertakers or their agents to a fine under this section, if they satisfy the court having cognisance of the case that the immediate execution of the work was required to avoid an accident, or otherwise was a work of emergency, and that they forthwith served on the postmaster or sub-postmaster of the postal telegraph office nearest to the place where the work was done a notice of the execution thereof, stating the reason for executing the same without previous notice. For the purposes of this section a telegraphic line of the Postmaster-General shall be deemed to be injuriously affected by a work if telegraphic communication by means of such line is, whether through induction or otherwise, in any manner affected by such work, or by any use made of such work. For the purposes of this section, and subject as therein provided, sections two, eight, nine, ten, eleven, and twelve of the Telegraph Act, 1878, shall be deemed to be incorporated with this Act, as if the undertakers were undertakers within the meaning of those sections, without prejudice, nevertheless, to any operation which the other sections of the said Act would have had if this section had not been enacted.

15. Where any matter is by this Act or any license or provisional order granted under this Act directed to be determined by arbitration, such matters shall, except as otherwise expressly provided, be determined by an engineer or other fit person to be nominated as arbitrator by the Board of Trade on the application of either party, and the expenses of the arbitration shall be borne and paid as the arbitrator directs.

16. In this Act, unless the context otherwise requires, the expressions "local authority" and "local rate" mean, as respects each district set forth in the first column of the schedule to this Act annexed, the authority and rate mentioned opposite to that district in the second and third columns of that schedule; and such schedule, and the notes appended thereto, shall be of the same validity as if enacted in the body of the Act.

17. In this Act, unless the context otherwise requires, the expression "electricity" means electricity, electric current, or any like agency. The expression "electric line" means a wire or wires, conductor, or other means used for the purpose of conveying, transmitting, or distributing electricity with any casing, coating, covering, tube, pipe, or insulator enclosing, surrounding, or supporting the same, or any part thereof, or any apparatus connected therewith for the purpose of conveying, transmitting, or distributing electricity or electric currents. The expression "works" means and includes electric lines, also any buildings, machinery, engines, works, matters, or things of whatever description required to supply electricity, and to carry into effect the object of the undertakers under this Act. The expression "company" means any body of persons corporate or unincorporate. The expression "Lands Clauses Acts" means the Lands Clauses Consolidation Acts, 1845, 1860, and 1869.

18. Nothing in this Act shall exempt the undertakers or their undertaking from the provisions of any general Act relating to the supply of electricity which may be passed in this or any future session of Parliament.

As to Scotland.

19. This Act shall apply to Scotland, with the following modifications:—The expression "Lands Clauses Acts" means the Lands Clauses Consolidation (Scotland) Acts, 1845 and 1860. The expression "simple larceny" means theft.

As to Ireland.

20. This Act shall apply to Ireland with the following modifications:—Where the consent of the grand jury of any county to the breaking up of any road is required under this Act, such consent may be signified by the county surveyor; and where it is required under this Act that notice should be given by the Board of Trade to the grand jury of any county, and an opportunity afforded to such grand jury to state objections, such notice may be given to, and such objections may be stated by, the county surveyor on behalf of the grand jury. The expression "Public Health Act, 1875," means the Public Health (Ireland) Act, 1878.

ELECTRICITY AND GAS *VERSUS* SMOKE.*

(CONCLUDED FROM PAGE 294.)

So much for stationary engines. I have now to show that locomotives may be worked on short lines by electricity with great ease and with considerable economy. And if there is one line more suitable than another for such an application it is the elevated railway such as is extensively used in New York, and such as is projected along the line of docks at Liverpool. The current supplied to the rails will be taken up by the wheels, which must be insulated from one another. The rails also must, of course, be insulated from each other and from the ground. This constitutes a serious difficulty in the application of electricity to tram lines on common roads, where the rails must be sunk in the ground; but it is quite possible to lay an ordinary line of railway so that the rails shall have a sufficient amount of insulation, provided the length of the line is very moderate, say a dozen or twenty miles. Messrs. Siemens have worked a passenger electric railway at Berlin for some time, and are now constructing another at Portrush, which is to utilise the power of a neighbouring waterfall. In an overhead railway, however, there ought to be no difficulty about the insulation whatever, even in the muddiest weather. Moreover, there will be an immense saving in the strength of the structure. The principal weight in a train is the locomotive, but an electric train will have no separate locomotive. A dynamo is enormously lighter than any other machine of equal power, and if supplied to an ordinary detached locomotive the weight would not be sufficient to make it bite the rails. The compactness of the dynamo enables it to be supplied to every carriage, and thus the immense weight and consequent wear and tear of the rails by the steam locomotive is avoided. Every wheel may be separately driven by the power, just as now every wheel can be simultaneously braked.

But under these circumstances it is little use to make up a train; each carriage can run by itself, and it would be much more convenient to passengers to have a single carriage running every minute than it is to have a train of carriages every quarter of an hour. The same current supplied at the central generating station will drive a number of motors at the same time quite easily. Here, for instance, is a model railway with two trains running at once.*

When we consider the smoke and the ashes, the noise and the unsightliness, of the New York elevated steam railways, we ought, I think, to be satisfied that for the elevated railway along the Liverpool docks nothing but electricity ought to be tolerated; and then, when the central generating station is once established, it might just as well do a little extra work and light up the docks at the same time. Moreover, a number of Hopkinson's portable electric hoists would be of immense convenience; in fact there is scarcely any limit to the uses that might be found for electricity in a busy place like that, and the railway might turn out to be scarcely the most important of them after all. The large condensing engines at the central station ought to go on working continuously, filling up a large secondary battery or other store of energy during the night.

Now comes the question whether electricity can ever be applied to the propulsion of ships. For short runs the answer is "Yes;" for long voyages apparently, "No." Such ferry steamers as the Birkenhead and New Brighton boats would be much improved by being rendered smokeless, smell-less, and noiseless. The smell of hot oil is disagreeable, the smoke is disagreeable, and the thumping noise on board some of the small boats is very disagreeable. From all these an electric boat will be perfectly free.

It must carry its own secondary batteries, and these must be charged by the mooring cable from a large battery on the landing stage (replenished by a constantly running dynamo) while taking in passengers. [A small model boat was shown.]

Already they talk of running an electric boat between Folkestone and Boulogne. In these days of tunnels steamboat companies must look alive and improve their mode of conveyance, or passengers will desert them. A little competition is the finest thing, whether for gas or steamboat companies.

The whole subject of secondary or accumulator batteries I have left untouched. It is most important, but I could not touch everything; and, fortunately, Professor Ayrton will be treating this very subject in a month or two in this place (London Institution).

When I said that I did not see how ocean steamers could be driven by electricity, I by no means delivered them and their

* A lecture delivered by Professor Oliver Lodge, partly at the London Institution and partly at St. George's Hall, Liverpool, in December, 1881.

* With such an arrangement, and no drivers, collisions are of frequent occurrence; but Ayrton and Perry have quite recently published a scheme by means of which any number of trains may travel on the same line without drivers, and, yet, shall never be able to come within a certain fixed distance of one another. They have also a plan for cutting up a line into sections, and of supplying the current only to those sections on which a train may happen to be, thus avoiding much leakage. These devices are, no doubt, exceedingly important, and seem to make it probable that electricity will eventually be able to supersede steam-power on the very longest lines; and may do away with the present fearful complexity in signalling apparatus, by abolishing signals altogether. Such a consummation is devoutly to be wished, for it may enhance at the same time the speed, the safety, and the comfort, of railway travelling. On an electric railway, kept properly watered, or possibly laid down with asphalte to begin with, a long railway journey in the summer might be really enjoyable, instead of begriming one with smoke and dust, and rendering anything like fresh air out of the question.

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passengers over to the smoke demon. Dr. Siemens has a plan of generating gas on board ship by mechanically-fed and smokeless generators, and then either heating the boilers by this gas, or else feeding a new form of gas engine with it. Something of this sort will certainly be done, and the firemen relieved from their fearfully monotonous labour of perpetually pitching coal into the furnaces all the way to America. Smoke is better on sea than on land, but it is a nuisance anywhere; it is exceedingly wasteful, and it can be avoided.

I have now endeavoured to point out to you the main lines on which we are to expect, during the next twenty or thirty years, great and rapid progress in the application to the wants of humanity of powers and forces and principles already well known in a theoretical manner; and I trust that you feel with me that the benefits likely to result from such application are of incalculable importance, and confer upon the subject a degree of interest that can scarcely be surpassed.

We have looked forward to a time when a town will have not only the means of illumination, but also the means of heating, and all its necessary power, laid on in wires or pipes, and turned on and off by a tap, as gas is now. Other things, such as telephones and time, will, no doubt, also be laid on to a far greater extent than they are at present; so that all the clocks in the place may be kept absolutely synchronous by regulating currents sent out from a central station or observatory; and everyone may communicate with shops and places of business by speech instead of by post cards. But these are minor improvements compared with the others of which I have spoken.

When blacks, and smoke, and noxious gases have been abolished, when the rays of the sun are allowed to penetrate unfiltered even to the veriest slums of the city, life in a well-drained town may become the most exhilarating tonic. Grass will grow, flowers will bloom, trees will flourish luxuriantly in the very heart of the great centres of civilization, and apple trees may yet again begin to blossom in the Barbican, as they did only two hundred and fifty years ago, when an eminent gardener (John Evelyn, in 1644) began to lament that they were becoming stunted and fruitless, owing to the "cloud of seacoal and pestilent smoke" then beginning to be evolved from the chimneys of the metropolis. Relieved from the grimy, slimy coating which covers one's hands, one's pavements, one's houses, and one's statues, who shall say what glories of architecture, also, may not even yet blossom forth among us. It is impossible to suppose that the monotonous ugliness of a modern street will be tolerated when it is perceived that the walls are willing to cover themselves with mosses and lichens; indeed, it is difficult to over-estimate the change, or to set a limit to the extent of its operation. The repulsive hideousness of daily life will be diminished; artists will be able to delight their souls with colours now only fit for an Italian sky, without needing to consult the chemist as to the effect of sulphur and smoke on their productions; and the long train of evils which science half applied has brought in its train, the Philistinism it has engendered, and the repulsion it has excited in the souls of artists and beauty-lovers, will be terminated—not by the extinction of science and progress, as some of them have wildly wished—but by a revolution and reform in the whole of practical existence, which science, half known, has done so much to disfigure, but which, better known, it can only beautify and adorn.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).

The seventeenth ordinary general meeting of this Company was held at the City Terminus Hotel on the 19th inst., under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the minutes of the 16th ordinary general meeting, which was held on the 19th October, 1881. These minutes were confirmed by the present meeting, and signed by the chairman as correct, and the report of the directors was taken as read.

The CHAIRMAN: Six months ago when I had the pleasure of addressing you I had then to announce the death of Colonel Glover, who had been connected with this Company from its commencement as managing director. I am sorry to say that on this occasion I have another death to announce—that of the Right Hon. Mr. Massey. Mr. Massey was one of the first directors of this Company, and as a member of the board no man showed a sounder judgment, or a greater interest in the affairs of the company. Being identified with it from its commencement he continued throughout to show similar interest. His large experience of India enabled him to prove to us a very valuable and very efficient director, and we deeply regret his loss. I may remind you that we made a promise to the body of the shareholders at the time the fusion took place of the old Companies into the present Company that we would by degrees, and as opportunity offered, reduce the number of the directors. This we have carried out, and I only regret that the reduction should have taken place in the way it has done [hear, hear]. Gentlemen, since I last addressed you we have completed a very important work—namely, the line from Singapore to Batavia, which consists of a cable of a special make. We suffered in our first cable by the action of the teredo, a small insect which we had very great trouble to contend against. I stated the last time I mentioned the circumstances of the laying of that cable, that the cable we proposed to put down would be covered with a brass tape, and that it was likely to resist any action of the teredo. I believe that our views are correct, and so far it has been laid with perfect success and is working very successfully. We have also been successful in picking up nearly the whole of the cable which this cable has replaced. We are re-serving that cable, and shall lay it down when required for probable extensions or to duplicate existing lines. I may mention that looking to the fact of the interruptions which take place so frequently, had we not duplicated our cable to Australia, at the present time we could not maintain the dividends which we continue to pay. But the interruption to one cable leaves us another cable to deal with, and the result has been that we are secured in our traffic, and consequently enabled, as I think our financial statement will show you, not only to pay you a respectable dividend, but to add very largely to our reserve, and, at the same time, lay this new cable out of income, instead of adding to the capital. I think this state of things must be considered by the shareholders as very satisfactory. Our system, with the exception of small interruptions that have taken place, has been working most successfully. We have some smaller extensions still to carry out, and I hope we shall be able to complete them also without adding to our capital. For instance, we think it is very likely at no distant date that we shall carry a line of cable from Hong Kong to Macao, one of the Portuguese settlements. Your interests are being very carefully watched in China, and so far as I can see the prospects of revenue are very encouraging. As you will observe from the accounts, the gross receipts for the half year ending 31st of December amounted to £205,963, against £193,435 in the corresponding period of 1880, showing an increase of £12,528 for the half year under consideration. The expenses, on the other hand, have decreased about £5,000. This is principally accounted for by a reduction of £4,000 in the cost of cable repairs in the last half year. If we could only get rid of these repairs and could have our steamers laid up, we should be able to make even a better appearance than we do before you to-day. The net revenue for the half year has been £111,334 against £93,493 for the corresponding period of 1880, showing an increase of £17,841. If, moreover, a comparison is made between the working of the whole of the past year and the whole of 1880, the result is equally satisfactory. The gross receipts during 1881 were £397,543 as against £366,453 for 1880, showing an increase in favour of 1881 of £31,090; while the actual working expenses during 1881 were £105,741 against £106,505 in 1880, being a decrease of £764 for 1881. During the half year an interim dividend of 1½ per cent. has been distributed, and another of similar amount has been declared, together with a bonus of 1s. per share, which will be payable on the 20th instant. These amounts, together with those paid during the first half year, make a total payment of 6 per cent. for the year 1881. In addition to that, as I have mentioned, we have added considerably to the security of your property by laying this additional cable, and by paying for it so far out of revenue. We have paid £30,000 this year besides putting a very handsome sum to reserve, and we intend to pay the balance out of the current year's earnings. The cost of it was £95,000, but the cable taken up has reduced that amount to £64,000. I may, however, mention that, while we take that at a valuation in our accounts, it will, when laid down, answer as a duplicate cable, and prove valuable to us for a very considerable time to come. The balance of £51,876, which remains after meeting all claims, has been carried to reserve fund, which, including that amount, now stands at £276,203, or equal to about 13¾ per cent. on the share capital. I think we are doing wisely in increasing the reserve fund. When we get it to a point that makes us perfectly independent, and prepared to lay a new cable in the event of its being required, we shall be enabled to go into the market with the money in our pockets, and secure the cable at the cheapest possible rate. The idea that existed for a very long time that the life of a cable was ten years is being pretty much exploded now, because we find that our cables are in such a depth of water that we can take them up and repair them. I do not know that we cannot add an additional ten years on to their life. So far as our experience goes, the core of the cable, when picked up, is just as good as on the day when first laid down. I may mention, as you all know, that we have in these companies been engaged more or less in a speculation—not a financial speculation, but the nature of the work has been speculative. We are, however, year by year gaining experience, and we are enabled to say to you to-day with greater confidence than ever before that you have a reliable property. I think it is a very important step that we have attained this position, and I trust that every year will still further increase our belief in the value of submarine cables as a property. We entered into an arrangement the other day with the Governments of Tasmania and Victoria for a reduction of our tariff on the cable between those two points; and I am glad to say that the reduction has increased the traffic, and given us a larger return than we had at the higher rate. That is very satisfactory indeed, and I would only say that while we are most anxious to protect the interests of our shareholders, to give them a fair dividend, and to put by such a reserve as will secure that dividend, we shall, at the same time, always endeavour to meet the wishes of our customers, and to give them increased facilities either in the way of reduced rates or in other ways that may be equally beneficial. At the same time, I must say that we shall consider the shareholders' interests first. With these remarks, I beg to move the adoption of the report and accounts.

The Right Hon. Viscount MONCK: I beg to second that.

The CHAIRMAN: The resolution is "That the report and accounts of the directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. a share, together with a bonus of 1s. a share, both free of income-tax, payable on the 20th inst., making, with previous distributions, a total distribution of 6 per cent. for the year 1881." If any gentleman has any remark or suggestion to make I shall be very glad to hear and answer him. If not, I shall put the resolution.

Mr. STOKES: I am sure we must all feel very grateful to have such a splendid report as this which we have to-day. There is one point I did not quite understand. Did the chairman say that the cable taken up was going to be laid at any particular place, or whether they have to make one? I would merely wish to ask that question.

The CHAIRMAN: We have two or three cards to play just now in regard to that cable, and I think it better that I should not state them publicly.

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We shall utilise that cable in a way that by and bye we believe you will approve of. It will not lie idle, you may depend on it.

A SHAREHOLDER: May I ask whether the cable that has been taken up is much damaged by the insect you speak of? Has it been found in good repair?

The CHAIRMAN: At the last meeting I brought and laid on the table a section of that cable to show how the insect damaged it. We have out at Singapore a hulk in which we have all the machinery necessary to do what is called re-serving the cable, and in re-serving it we make up all those defects, and we then put it into the sea again in about as good condition as it was at first.

Another SHAREHOLDER: Has this destructive insect made its appearance in any other point than where this cable was laid?

The CHAIRMAN: I am sorry to say that it has appeared at many points, but it has not been so destructive at any point as it has been at this. I stated at the last meeting that these insects were costing us £7,000 or £8,000 a year at this particular part, and that by putting down this cable at a cost of something like £60,000, we hoped to be free from that outlay, which was becoming a regular payment every year for repairs. We have had this ribboned cable in operation for four years, and have had no fault, but as I stated just now the insect is not confined to this part, though it is a great deal more there than at other parts. Those in favour of the resolution will please hold up their hands. To the contrary. Carried unanimously. Continuing, he said: The next resolution is, "That Mr. Alderman McArthur, M.P., who now retires by rotation, be and he is hereby re-elected."

The Most Honourable the Marquis of TWEEDDALE seconded the motion.

The CHAIRMAN put it in the usual manner, and declared it carried unanimously. The next resolution is, "That George Garden Nicol, who now retires by rotation, be and he is hereby re-elected."

Sir JAMES ANDERSON seconded the motion.

The CHAIRMAN put it, and it was carried unanimously.

Mr. NICOL: Gentlemen, I beg to thank you.

The CHAIRMAN: The next resolution will be moved by one of the shareholders.

Mr. J. S. STARNES: I beg to move "That Mr. Henry Dever and Messrs. Quilter, Ball, and Co. be re-elected auditors for the ensuing year, at a remuneration of £50 each."

Mr. L. MARCUS seconded the motion.

The CHAIRMAN put it, and it was carried unanimously. He added: That concludes the business of the meeting, and I am much obliged to you for your attendance.

Mr. STOKES: I shall have great pleasure indeed in proposing that a cordial vote of thanks be given to the chairman and directors for their services in the past year.

Mr. NEWTON: I shall have great pleasure in seconding the resolution, and in doing so I wish to say a few words as to the accounts. We have added to our reserve fund £80,000 in the past year, and in the following year we are going to add another £80,000 to that fund. If you look to the accounts as carefully as I do, you will see that we are adding to our cables out of revenue. I think it is right that it should be noted that we renew our cables out of revenue, and add £50,000 a year to the reserve fund.

The motion was carried unanimously.

The CHAIRMAN: I am very much obliged to you on behalf of my co-directors and myself. I can only say, referring to the remarks of Mr. Newton just now—and I am quite sure that Mr. Newton does look very carefully at these accounts—that the opinion he has just expressed is endorsed by the Stock Exchange, who have a pretty keen eye as to the value of any property. I think that at the present day our shares look well, and that they are likely to improve in value [applause].

The proceedings then terminated.

ORIENTAL TELEPHONE COMPANY (LIMITED).

The annual general meeting of this Company was held on the 19th inst., under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. W. G. Hall) read the notice convening the meeting and the minutes of the extraordinary general meeting held on the 28th December last, which were approved by the present meeting, and signed as correct by the chairman. The report of the directors, an abstract of which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN: Before asking you to approve the report, I have no doubt that it will interest you if I give an outline of our proceedings since I last had the honour of addressing you. Some four months ago we called you together for the purpose of confirming an amended agreement with the vendors of the patent rights and privileges to this Company. I then made a statement as to the prospects of this Company, and I am glad I am in a position to-day to confirm all that I said at that time, and to give you an idea of the present position of the Company. Before doing that, however, I would like to make a few remarks on the accounts. The only items in the balance-sheet presented to the shareholders which may have to be explained are the following:—On the debit side, the item of credit balances £4,000 0s. 9d. This sum represents amounts due for material and other charges not paid prior to 31st December, but chargeable against the period embraced in the accounts. On the credit side there is an item of preliminary expenses, £5,296 12s. 2d. The items composing this sum are advertising, brokers' commission, legal expenses, stationery, &c.; and these amounts are moderate compared with the general statements I have seen in bringing such companies before the public. Most of these accounts are, of course, not likely to be repeated. The item debit balances, £1,225 3s. 8d., represent amounts due to the Company for sundry items to be credited to the period embraced in the accounts, but not recovered on the 31st of December. Now, gentlemen, when I had the pleasure of addressing you last I stated that in Egypt we were making considerable progress. That was our first station; and as you know in Oriental cities it takes not only time but expense to introduce any novelty. A telegram I received yesterday, however, speaks for itself. "Official opening of Cairo Exchange fixed for Friday next, 21st inst. Prospects excellent, and line admirably constructed. Khedive taking great personal interest in success. Telephone extensions in Egypt, as well as system of electric lighting." A further telegram states that we start in Cairo with sixty subscribers. Therefore, in Egypt—with Alexandria and its population of something like 150,000, and Cairo with its population of something like 600,000—there can be no doubt that the benefits of telephonic communication having once been tasted it is likely to spread rapidly. Statements have been made with regard to this Company and other companies as to their not at once beginning to pay dividends. You might just as soon expect a cotton mill to begin paying a dividend when you lay the first brick of the foundation. All this is a matter of mechanical construction. It has to be built and put in a position to work, and from that working you get returns. We have not been more than twelve months in existence, and eight months out of the twelve have been employed in India in making arrangements with the Government—in overcoming difficulties. I have attended very often at the India Office myself, and have had a great deal of trouble in connection with these difficulties, but, fortunately, the feeling and views of the Government at home were strongly in favour of encouraging private enterprise in India. The result has been that all those difficulties which took us quite eight months to overcome have been removed, and we have now made a start there. I had a telegram a short time ago from Major Baring, who is at the head of the Financial Department in India, and who is very much interested in encouraging private enterprise. I had a telegram from him on the opening of the system there, in which he congratulated the Company and its Board of Directors on the efficient way in which the work had been constructed, on the very short time it had taken to construct it, and as to the prospects of the Company, both in being largely beneficial to the Company as well as to the public. We have now in Calcutta by last advices 92 subscribers, in Bombay 61, in Alexandria 79, in Cairo 60, in Madras 23, in Hong Kong 15, in Shanghai 16, in Honolulu 187. When you look at Honolulu, with 187 subscribers, and when you look at Calcutta and Bombay, I trust that the next time I address you we shall find that the number of subscribers has enormously increased. I speak as a business man, and from some little experience of the advantages of telephonic connections. I went during the holidays to see what I had been told was, perhaps, the most successful telephonic action in Europe—at Antwerp. I saw there, the population of Antwerp being something like 150,000, a telephonic system with 800 subscribers; and, without exception, I think it was one of the most perfect systems of telephonic working I have yet witnessed. It is a marked and decided success, and if the same mechanical talent is applied elsewhere, I expect very great results from telephonic enterprise. As I have stated, our prospects in Calcutta are good, for I cannot conceive any place better suited for the telephone. The same observation also applies to Bombay. It has a large mercantile element constantly at work. It is under a sun which prevents men from moving from their offices, and it is especially suited to this particular class of communication. Therefore, I have no hesitation in saying that with a little time you will find the growth of this system increase in those particular cities. At the same time I may say that, with the growth of subscribers, the increase of return will be very largely in excess in proportion to the increase of expenses. Our expenses we expect rather to cut down, because we have had to employ rather a high class of men, who have been in the habit of receiving very high wages for constructing the system, but we believe, having employed the best men to do the work, that it is likely to continue to give us a more certain return on the capital invested. I have mentioned these different places in Egypt and India, in which I think our prospects are good. I may say that we received a telegram only yesterday informing us that arrangements have been made with the Government of Madras to connect five of the chief offices of the Government—the Governor's house, chief secretary's office, the chief engineer's office, the revenue board, and the master attendant's office. This is the beginning of what may prove of great importance to the Company, for we all know that the moment a Government begins to use a system of this kind, all mercantile men, and all, indeed, who can afford it, follow. From Bombay the agent writes that several of the chief mercantile firms have expressed themselves to the effect that the telephone saved them much time, labour, and money; and the manager of one bank stated he would be able, partly owing to the telephone, to render a better account to his directors of his business operations during the half year. In short, with the telephone, a banker sitting in his room can negotiate with every mercantile house in Bombay questions of bills and all those matters which spring up between merchants and bankers. These remarks show you pretty well the position we are in now, and that it is only a matter of time, I think, before we come to discuss the question of dividends. Now, in regard to that question, we have not yet been a year in existence, but we have received money in those parts where we are working. Up to the present time, however, our expenses have been exceeding our income, and until once the exchanges are fairly worked, and the numbers have increased, we cannot say much for dividend beyond this—that if we take the present position of this Company, and the short time it has been in existence, and compare it with companies established in England, we consider that we are very far ahead of them. Dividends have been paid by the United Company, the value of whose property stands in the market at a very high price, but they have been paid, not out of earnings from exchanges, but out of sales of their rights to other companies. Now, we have not yet attempted any sales of privileges which we hold in India; but I expect before long (having established these important exchanges in the important centres of commerce I have mentioned, and looking to the number of places which the Government wish us now to extend our system to) we may adopt the principle which has been adopted in England, of forming small companies who will pay us a certain sum for the privileges which we possess, and that we shall also, at the same time, retain a certain interest in the working of those companies. That is the mode by which we propose to extend our system in India, keeping down our capital account and basing our extensions on the creation of companies who will find the capital to carry on those extensions. I mentioned the United Company, and I may also mention the National Company. All these companies have been in existence considerably longer than we, and, therefore, although I have received some communications from some friends who are rather disappointed at no announcement of dividend, I think that all reasonable men will agree that time must be given to develop a system of this kind. In America it is in use to an extraordinary extent, and as a matter of interest I think I should give you some idea of its use in America at the present time. In New York there are 3,100 subscribers, in Chicago 3,500, in Brooklyn 400, in Cincinnati 1,800,

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in Philadelphia 2,000, in Buffalo 1,100, in Denver 700, in Boston 1,600, in Desmoyles 500, in South Bend, Indiana, 200, in Lafayett 200, in Indianapolis 750, and in San Francisco 1,280. I mention this to show you the growth of the telephone system in America. Well, the system was established there for three years before there was any dividend. Now they have got up to the point at which they pay a handsome dividend, and I give you these figures to show you what they are doing there. I believe that British enterprise and British merchants, knowing what they have to compete with, will not be behind in using this telephonic system, more particularly in the areas which we have undertaken to supply. There is no country better suited for telephonic enterprise than India, Australia, and China, for which we also possess rights. Taking the whole of our system together up to the present moment we have 533 subscribers, and we are informed by telegram that 170 subscribers will be added immediately to that number. In other words, we have now about 700 subscribers altogether, and we have not yet been a year in existence. I may say that we have not been in working yet for more than three or four months, so that these figures show very clearly that our prospects are very satisfactory. Speaking for myself, I know something of electrical science applied to telegraphy, and I think that the progress of telephony, remembering that it has been in existence only three or four years, is very marvellous indeed. Before asking you to approve the report I think it is right that I should refer to two letters I have received on the question of directors' fees. Now, while I am a very strong advocate of paying directors a fair remuneration for the work they do, I personally dislike receiving fees where no return is given to the shareholders. At the same time, directors cannot be expected to carry out a work of this kind without being remunerated. I have suggested—and I believe the suggestion will be adopted by the board—that we should materially reduce the sum we are entitled to receive by the Articles of Association until once we are in a position to pay a dividend to the shareholders. I must, therefore, ask you to leave the question meantime in the hands of the directors. All I can say is, speaking for myself, and I think I may also speak for two or three gentlemen at the board, I shall not receive one penny of directors' fees if this thing is not as great a success as I am prepared to view it. I am a large shareholder, and I look on it as a concern that must eventually give us a very considerable return. When we get the return I shall be as exacting as any man in expecting you to pay me for the labour and time I give you. With these remarks I beg to move the following resolution:—"That the accounts to the 31st of December together with the directors' report be approved and adopted."

Sir JULIUS VOGEL, K.C.M.G.: I beg to second this resolution. After the very lucid statement made by the chairman there is very little for me to add, but I would ask you to remember this—that this Company has a very large and wide field for the exercise of its powers, and for the growing commercial benefit from the use of the telephone; and I think if you consider what must be the progress of the telephone in the countries in which we operate, you must come to the conclusion that our prospects are of a very satisfactory character. The telephone has at present, I would say, made very small progress in Great Britain. In some parts of the country it is extensively used, but in London, considering its size and its enormous transactions, it is comparatively little used. There are, however, plenty of reasons to account for this. In this country there has to some extent been a rivalry between the telephone and the telegraph interests. There has been a great deal of litigation, and in the City, where ground is so valuable, there has been a difficulty in getting way-leaves. In Germany and America the telephone has progressed to such an extent as to prove to me that it must become an article of household use in all civilised countries, and I am quite sure in the East, where the climate is so hot, and it is so important to avoid exertion, and where commercial activity is so great, that the use of the telephone must become very general, and that our prospects are, therefore, very satisfactory. I think it is also important that you should remember this—that although we have no dividend this year, yet the holders of the shares which have been taken up are entitled not only to a preference dividend, but to a cumulative preference dividend over the vendors' shares to the extent of 6 per cent., so that really it is very little more than postponing a pleasure to come. With these remarks, I second the motion.

The CHAIRMAN: If any gentleman has any question to ask before I put the resolution, I shall be very glad to give him the best answer in my power.

Mr. FRANCIS BENNOCK: I am comparatively only a small shareholder, having only a few hundred shares, but we represent a good many friends whom I have induced to join the Company, and together we hold a very fair amount—at all events an amount sufficient to justify me in asking one or two questions. Primarily, I quite concur in the statements so lucidly made by the chairman, that all these difficulties with regard to a new company had to be looked at by the shareholders, because a very large amount of expense must be incurred before you can by any possibility receive any return. There is then the matter in regard to the prospects of dividend. That dividend will depend very much on the amount of your fixed expenditure. I do not know whether the board has gone into the question and satisfied their own minds as to the precise number of subscribers that there ought to be in the various cities in which your operations are introduced, how many subscribers will be sufficient to cover your entire expenditure. That will be a piece of pleasant information for your shareholders, because in proportion to the extent of your operations in the East you will be able to say when a dividend may be expected. It may take 2,000, 3,000, or 5,000 of these subscribers, but it would be pleasant for us to know that as soon as a certain number are found we may soon afterwards be prepared to receive a dividend. I think the statement made by the chairman in regard to the fees of directors is very satisfactory, but I hold, as a director in some companies, that the labourer is worthy of his hire on all occasions, and there is no worse policy than to be mean and contemptible in regard to remuneration of directors. If you have men who go into the matter for mere fees you will probably get very little service for your money; but if they go into it with the intention of making it a success, and themselves adventuring a large amount of their capital, and prepared to give their services for a small amount of remuneration, I think we are perfectly safe in leaving the matter of their remuneration in their hands. The only question of importance that I would ask is what number of subscribers will be sufficient, so far as you are able to judge, to cover the entire of your fixed expenditure?

Mr. BLADON: The statement of the chairman and the question of the previous speaker have taken from me almost all I was going to put; but there is one point that you have not alluded to, and on which, I think, the shareholders would like to have some information. At the extraordinary meeting I think your anticipation was that 10s. per share would be ample for your purpose under the new arrangement you then proposed. If you are able to confirm that, it may be satisfactory to the shareholders to hear that there is no probability of a call till a dividend is paid; at all events, when they would be glad to find more capital. As to the directors' fees, I think that every shareholder would wish that they should be paid, and the statement of the chairman that they are prepared to accept a somewhat small scale till we pay a dividend is very satisfactory. When we are able to pay a dividend the shareholders will not grudge the right amount.

The CHAIRMAN: I have great pleasure in replying to both the statements made. In the first place, I believe at the present moment that our income already about meets our expenditure [hear, hear]. I think I almost shadowed forth that in the remarks I made that the returns would increase by a very much larger per-centage than the expenditure. I think I also stated that the expenditure now is high because we have had a high class of men at work, but I made a remark the last time I addressed you which I may repeat. I mentioned, as probably most of you know, the deep interest I have in submarine telegraphy throughout the world. We have in connection with that system electrical and scientific men in almost every place where telephones are about to be introduced. I mentioned then my belief in electrical progress, and that I might materially benefit this Company through the position I hold in connection with submarine telegraph companies, and equally benefit those companies by bringing telephonic enterprise into our great centres, and that I hoped eventually we should be able materially to reduce the expenses of a company like this in the higher class of men. I mean the scientific men, because when our works in submarine telegraphy are working well our electricians have nothing to do; therefore, their time is on their hands. We shall utilise that, to some extent benefiting the men by paying them some small consideration, so as to conduct the electrical department of the the telephonic system. I think in mentioning this to you, that it will show you this connection is one that is very likely to benefit us, and that it will considerably reduce the expenditure of the Oriental Telephone Company in the countries where the Telegraph Companies have electricians. We are now negotiating for taking up a very important system in a part which I think it is just as well for me not to mention, because till once we have secured the thing, if it were known that we were dealing with it, we might have some competition, and therefore, I think it better meantime to say only that we are arranging that matter, and that we shall take it over on a paying condition—that is, that it will cost us nothing to establish. We shall pay a certain sum, and take over that concern with a certain income. If we can carry that principle out generally I do not expect we shall require to make a call at the present time, but there is one thing that I may assure you about, and that is, that we shall make no call and no extension of a nature that would involve a large increase of capital without consulting our shareholders on the subject. As regards India, I have merely to say that we are now being pressed by the Government to open telephone exchanges in other towns. We have, as you are informed in the report, commenced operations in the three Presidency towns, and arrangements are also being made to start in Kurrachee and Colombo. The Government urge us to take up other leading centres in the Empire, being apparently convinced of the utility of our system. To do this effectually we may be required to increase our capital. But there are two ways of doing that—by making a call, or by forming companies in India to work in connection with us there. [He then moved the resolution, and it was carried unanimously.] Continuing, he said: With regard to the resolution for the appointment of auditors, I have mentioned at the telegraph company's meetings that we prefer having a constant audit of our accounts, and we consider that that constant audit being in the hands of such a firm as Deloitte and Co. is the best guarantee to the public that the money will be fairly and honestly dealt with.

Mr. BENNOCK then moved the election of Messrs. Deloitte, Dever, Griffiths, and Co. as auditors for the current year at a remuneration of 100 guineas. The chairman had shown them the importance of having such gentlemen to watch over their affairs, and to certify the accounts. There was nothing more important than to have auditors in whom the directors had confidence, and on whom the shareholders might rely for a fair and right certificate in regard to the accounts they presented.

Mr. NEWTON having seconded the motion, it was carried unanimously.

The CHAIRMAN: There is a gentleman present who has been conversant with the telephone in America from the outset; but I have given you all the figures, and stated what has been done in America. Probably you would not care to have your time occupied in any statement on the subject; but, still, if the shareholders would like to hear the remarks of a practical man, Mr. Hubbard, who has established the exchange at Honolulu, and who is thorofighly practical as to all the extensions of the telephone from the beginning, will be very glad to make a few remarks [hear, hear].

Mr. S. HUBBARD: Mr. Chairman and Gentlemen—I might preface my remarks by saying that I have been connected with the telephone ever since its first commencement in 1877. During that time I have, of course, had considerable experience, have visited many of the largest exchanges in the northern part of the United States, and have carefully examined the various systems now in use. I must say this, that I know of no exchange in the United States, where they have had every advantage in perfecting their system, that has paid a dividend under two years, and, in the majority of cases, it has been three years—not less than two years in every case that I know of. When the business first commenced they were subjected to great opposition. After the opposition was removed, and satisfactory arrangements were made with the Western Union Telegraph Company, the companies then were on a firm basis, but the expenditures were so great in construction of lines and delay in obtaining their subscribers, that it has taken, as said before, fully two years before any company could pay a dividend. In other words, a landlord does not expect to get rent for his house until it is finished, and, although you commence an exchange with a subscription list of from fifty or a hundred subscribers, it takes time to build your lines and make the proper connections. As to Honolulu, I went there in the fall of 1880 with a promise of forty-five subscribers. We

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thought that sixty, perhaps, would be the limit. As soon as the exchange was open with about fifteen or twenty connections, the people were so pleased with its working, that we could not begin to fill our orders for connections. The consequence has been that, up to the latest advices, there are 187 subscribers, and that number will materially increase by further extensions to the other side of the island. If a little place like Honolulu, with a popolation of about 2,500 or 3,000 whites in an isolated island in the Pacific Ocean, can obtain that number of subscribers, what will take place in India, China, Egypt, and other places? Certainly tenfold. In all of the principal cities of the United States—I may say almost every town of 2,500 to 3,000 inhabitants—a telephone exchange exists, and in every case I know of it has been a success. I don't know that I can say any more at the present time on this subject.

The CHAIRMAN: That, gentlemen, then, concludes the business of the meeting.

Mr. BLADEN thought that before they separated they should pass a vote of thanks to the chairman and directors. There was no doubt that their labours were very much greater now than the shareholders had any idea of, and that in future, when they would receive a better rate of remuneration, because the shareholders would receive a dividend, their work would be much less difficult than it was now. He, therefore, thought the shareholders should pass a hearty vote of thanks to them.

A SHAREHOLDER seconded the motion, and it was carried unanimously.

The CHAIRMAN: On behalf of myself and the directors I can only say that our heart is in our work, and that our pockets are also interested, and you may therefore rest assured there will be no want of exertion on our part to make this a thoroughly successful company, not only to the shareholders but also largely beneficial to the general public who use our system. Depend upon it, the telephone is going to become a very important element of communication not only in commercial, but also in political and social life. See the progress already in our Government offices. All the offices are now put in communication. They can communicate with each other, and ask questions and get answers in a minute or two. I was at the Colonial Office last night, and wanted to know what was going on the Foreign Office. I got an answer in two or three minutes. In former times you had to leave one office and go over to another, and to go through all the routine. The facility of the system is so great that it is simply impossible that any man transacting business of importance can be without it. That is my impression of the telephone, and, therefore, I look for a very great increase of telephonic communication not only in England but throughout the world. England is really very far behind in this matter—a fact which is very extraordinary. This company has now actually about 600 subscribers, within four months of our working. The National Company has been going on for some considerable time, and that, perhaps, is one of the most successful of the companies. They last year had 1,087 subscribers, and this year they have 1,510, whereas we have already got, practically, about 700; and before I meet you again I expect we shall have ——.

Mr. BENNOCK: 7,000 [laughter].

The CHAIRMAN: Well, I expect we shall have a very large increase ndeed. I am very much obliged to you for your vote.

The meeting then separated.

THE GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

Report of the directors to be submitted to the ordinary meeting to be held at 66, Old Broad-street, on Wednesday, April 26.

The directors beg to submit the accounts and balance sheet for the twelve months ending December, 1881, including in the accounts the coupon to that date receivable from the German Union Company of Berlin. The total receipts during the twelve months amount to £12,968 1s. 6d., which, with a balance of £139 12s. 11d. carried forward from last account, make a total of £13,107 14s. 5d. The working expenses for the same period amount to £565 9s. 1d., leaving a balance of £12,542 5s. 4d. Out of this amount an interim dividend of 5s. 9d. per share was distributed on the 21st January last, and the directors recommend the payment of a further dividend of 6s. 9d. per share, making a total distribution for the year of 12s. 6d. per share, free of income-tax, or at the rate of £6 5s. per cent. per annum, leaving a balance of £11 0s. 4d. to be carried over to the next account. Since the last ordinary general meeting the Berlin Company has successfully laid the cable between Greitsceel, in Germany, and Valentia, in Ireland. This cable will be opened for traffic on the 22nd April. The new line provides a direct telegraphic communication between Germany and the United States, and will serve as a duplicate route tending to ensure a steadily-increasing revenue. The Berlin Company, to meet the cost of the new cable, have issued £165,000 5½ per cent. preference capital, and part of these preference shares were, in accordance with their statutes, offered to the shareholders of this Company. The board hoped to have made arrangements whereby these preference shares would have been represented by an equivalent security of this company, but so far this has been deemed inexpedient. The necessity for the new cable has been, unfortunately, demonstrated by the temporary interruption of the original cable. Although great efforts were made, the repair was difficult, and delayed on account of bad weather. Communication is now fully restored, and the line is working well. The board have to announce with regret that considerations of health led Mr. Henry Weaver to resign his seat at the board. The directors have in his stead appointed Mr. John Denison Pender, who, retiring by rotation, and being eligible, offers himself for re-election. The auditor, Mr. Henry Dever, also retires, but offers himself for re-election.

INDO-EUROPEAN TELEGRAPH COMPANY.

The report of the directors of this Company for 1881 states that the revenue from all sources amounted to £100,101 8s. 8d., and the expenses to £47,377 0s. 5d. After charging the percentage upon profits payable to Messrs. Siemens, deducting the interim dividend, and placing £8,000 to the credit of reserve, a balance of £23,875 16s. 6d. remains to be dealt with. The directors recommend a dividend of 17s. 6d. per share, making, with the previous distribution, six per cent. for the year, and a bonus of 10s. per share, leaving £500 16s. 6d. to be carried forward. The contract with Messrs. Siemens for the maintenance of the line will expire on July 31 next, and the Company have arranged to perform this work afterwards by their own servants.

THE CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

Report to be presented at the adjourned first general meeting of the Company, on Monday, April 24. The directors have much pleasure in presenting to the shareholders a statement of accounts and balance sheet to March 31, 1882. The manufacturing operations of the Company have extended little over a period of six months, and they have been conducted under great disadvantage, owing to the factory first established proving too small for the demands upon its resources. The net profits of the Company amount to £23,087 13s. 9d., out of which £5,000, equal to sixpence a share, was paid as an interim dividend on the 31st December. At the time the interim dividend was declared, the directors announced it to be their intention to pay regular quarterly dividends of the same amount, feeling assured that the shareholders would approve of this policy. They therefore propose to pay regular quarterly dividends on the 30th June, the 30th September, and the 31st December. The balance of dividend for each year ending 31st March will have to be declared at the annual meeting. To enable this course to be adopted it has been thought desirable to carry £6,000 of the profits to a suspense account to guard against any possible loss on the outstanding balance due to the Company. It must be understood that this is not in consequence of any of the assets being considered doubtful; but as the outstanding accounts are large, and likely to continue to be so, it is considered that this reserve will operate as a measure of protection. Out of the balance of £17,087 13s. 9d., £1,458 0s. 4d. has been written off the preliminary expenditure account; and the directors recommend that £5,000 be appropriated to the present dividend, and that the balance of £5,629 13s. 5d. be carried forward. There will thus be more than the next quarter's dividend in hand. For interests the Company possessed abroad, it has received £20,000 (less a commission of £750) in shares in the River Plate Telephone and Electric Light Company (Limited); and £175,000 in shares in the Edison Gower-Bell Company of Europe (Limited). The first of these is estimated to be fully worth the nominal value. At present it is difficult to precisely estimate the value of the second. The two together the directors propose shall be held in suspense to cover possible depreciations. At present it is not proposed to recommend dividends beyond 10 per cent. per annum, but the shareholders may reasonably look forward to the time when it will be prudent to distribute special bonuses in addition. The business of the Company is in a most satisfactory condidition. It has orders and contracts in hand, the execution of which will keep it fully employed for a long time to come, and the demand for telephones is continually on the increase. The new factory is well fitted up, and there is every reason to believe that it will answer the purposes of the Company.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES APRIL 19.		BUSINESS DONE WEEK ENDING APRIL 19. Highest.		Lowest	
Anglo-American	53¼,	54	.....	53¼	.....	52½
Do. Preferred	83½,	84½	.....	83½	.....	82
Do. Deferred	24½,	25	.....	24½	.....	23½
Brazil Submarine	10½,	11½	.....	11½	.....	11
Cuba	8½,	9	.....	8½	.....	8½
Do. Preference	15½,	16½	.....	—	.....	—
Direct Spanish	6,	6½	.....	6½	.....	—
Do. Preference	15,	16	.....	—	.....	—
Direct United States Cable	11½,	11½	.....	11½	.....	11½
Eastern Telegraph	10 1-16,	10 3-16	.....	10 3-16	.....	10
Do. 6 per Cent. Preference	12½,	13½	.....	13½	.....	13 1-16
Do. 5 per Cent. Debentures, 1899	104,	107	.....	—	.....	—
Eastern Extension	11 9-16,	11 11-16	.....	11½	.....	11½
German Union	9½,	10½	.....	10½	.....	—
Globe Telegraph and Trust Company	6½,	6½	.....	6 7-16	.....	6 5-16
Do. Preference	12½,	12½	.....	12½	.....	12 3-16
Great Northern	12½,	13½	.....	13½	.....	12½
Indo-European	30,	31	.....	30½	.....	—
Mediterranean Extension	2,	2½	.....	2 3-16	.....	—
Do. Preference	9,	9½	.....	9½	.....	—
Reuter's	13½,	14	.....	13½	.....	—
Submarine	260,	270	.....	265	.....	—
West India and Panama	1½,	1½	.....	2	.....	—
Do. 1st Preference	8½,	8½	.....	8½	.....	8½
Western Brazilian	8½,	8½	.....	8 15-16	.....	—
West. Union 7 per Cent. 1st Mortgage	124,	129	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	102,	105	.....	—	.....	—

TELEPHONES.

Consol. Telephone and Maintenance	1 7-16,	1 9-16	.....	1½	.....	—
Oriental	⅛,	¼	.....	¼	.....	—
United Telephone	13½,	13¾	.....	13 9-16	.....	13½

ELECTRIC LIGHT.

Eastern Electric Light and Power	3½,	3¾	.....	3½	.....	3½
Electric Light and Power	9-16,	11-16	.....	½	.....	½
Anglo-American Brush	12,	12½	.....	12½	.....	11½

TRAFFIC RECEIPTS FOR MARCH, 1882.

COMPANIES.	March, 1882.	March, 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	4,000	3,124	876	—
Direct Spanish Telegraph Company	2,332	1,492	840	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,677	29,661	4,016	—
Eastern Telegraph Company	48,824	51,206	—	2,382
Great Northern Telegraph Company	19,680	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,490	1,635	1,855	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2618. IMPROVEMENTS IN GOVERNING DYNAMO-ELECTRIC MACHINES, &c., *J. Jameson.*—*16th June*, 1881.—(*Not proceeded with.*) 2*d*.

This invention consists in the use of a solenoid, with a bar of soft iron and a spring acting against the induced magnetism. This arrangement is so connected with the machinery as to control the speed of the dynamo-machine, and consequently the current.

2890. BLEACHING ANIMAL AND VEGETABLE FIBRES, *W. A. Barlow, London.*—*2nd July*, 1881.—(*A communication from L. Naudin and J. Schneider, Paris.*) 6*d*.

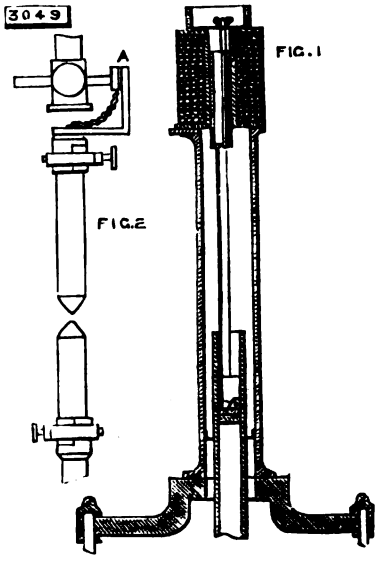
The electrodes of any electrical source are placed in a trough or tub, containing the fibres to be bleached, and a solution of a compound body which will serve to liberate an oxidising agent in the nascent state by electrolysis, as chlorine, oxygen, &c.

2944. IMPROVEMENTS IN THE MANUFACTURE OF ELECTRIC TELEGRAPH WIRE ROPES OR CABLES, *J. P. Hooper, London.*—*5th July*, 1881. 6*d*.

The object of this invention is to avoid springiness in paying out, and the consequent formation of kinks. To do this the inventor uses strands having a right hand and left hand way alternately for the outer covering of the cable.

3049. IMPROVEMENTS IN ELECTRIC LAMPS, *F. W. Haddan, London.*—(*A communication from L. G. Woolley, Mendon, Mich., U.S.*)—*12th July*, 1881. 6*d*.

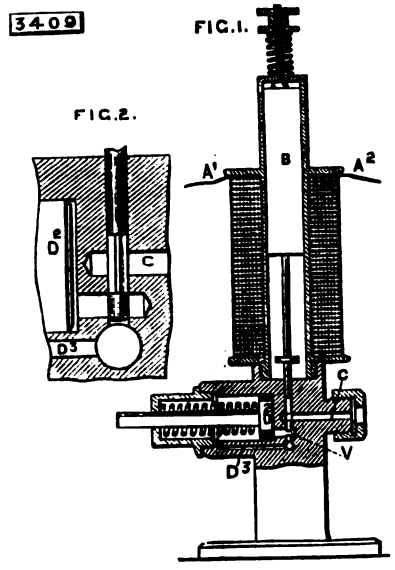
In this lamp the regulation of the carbons is effected by the helix and rod attached to the upper carbon holder shown in section in Fig. 1. The parts are made to work in glycerine to insure steadiness. According as the core is attracted down or up, so the upper carbon is moved. When it is attracted in an upward direction the elevator catches hold of the inside of the carbon holder,



and raises it vertically upward, preventing its binding upon its guides. The lower portion of the upper carbon holder is made in two parts, united by a fusible solder at A, and also by an insulated chain, Fig. 2. Should the holder become heated from any cause, the solder will melt, and the upper carbon drop on one side, thus breaking the circuit, the portion broken away being held by the insulated chain.

3409. AN IMPROVED METHOD AND APPARATUS FOR REGULATING THE DYNAMICAL PRODUCTION OF ELECTRICITY, *G. Westinghouse, jun., London.*—*6th August*, 1881. 6*d*.

The inventor uses the electricity itself to operate an electrical governor, as illustrated in the figure. A^1 and A^2 represent the circuits. Should the current be too strong in A^1 and A^2, the core B is attracted downwards, valve V depressed, and fluid or steam passes from C to piston D^2, causing it to advance and close, more or less, the regulating valve of the steam engine to which it is attached, thereby lessening its speed and that of the dynamo machine it is driving. The opposite effect takes place if the current be



too weak. Fig. 2 gives details of the valve arrangements. The waste steam or fluid escapes by the passage D^3.

3224.—IMPROVEMENTS IN GALVANIC BATTERIES, &c., *J. Higgin and A. J. Higgin, Manchester.* *23rd July*, 1881.—(*Not proceeded with.*) 2*d*.

This consists in the use of tin and carbon for the elements in a solution of dilute sulphuric acid.

251,537. DYNAMO-ELECTRIC MACHINE, *Thomas A. Edison, Menlo Park, N.J.*—*Filed August 30th*, 1881.

Brief.—Improvement on Letters Patent No. 242,898, dated June 14, 1881. Two series of concentric insulated rings are substituted for the radial bars of the above patent for making connection between the bars of the armature. *Claim.*—(1) In a dynamo or magneto-electric machine or

electric engine having a cylindrical armature, the concentric rings for connecting the inductive bars, substantially as set forth. (2) In a dynamo or magneto-electric machine or electric engine, the combination, with the cylindrical armature core, of the longitudinal inductive bars, two series of concentric rings, and commutator connections, substantially as set forth.

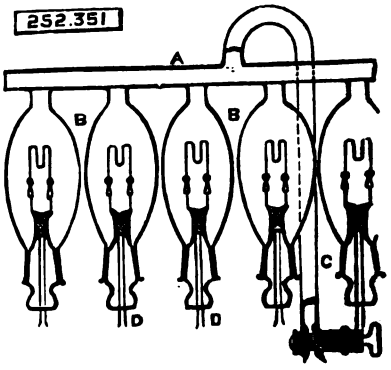
251,540. CARBON FOR ELECTRIC LAMPS, *Thomas A. Edison, Menlo Park, N.J., assignor to the Edison Electric Light Company, New York, N.Y.*—*Filed August 6th*, 1881.

Claim.—(1) A slip or filament for forming on carbonisation the incandescing conductor of an

electric light, made of bamboo or similar fibre, substantially as set forth. (2) An incandescing carbon conductor for electric lights, made from cane, bamboo, or similar fibre, substantially as set forth.

252,351. APPARATUS FOR THE PREPARATION OF CARBON CONDUCTORS, *Ludwig K. Böhn, New York, N.Y., assignor in the United States Electric Lighting Company, same place.*—*Filed June 23rd*, 1881.

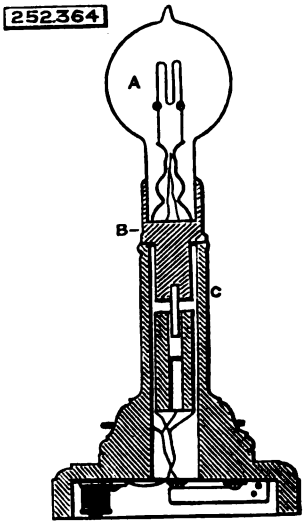
Claim.—(1) The combination of two or more separate carbon depositing or testing receivers, each closed by a plug or stopper containing the metallic conductors to which the carbons are attached, the several receivers being connected by a pipe or tube common to them all, and adapted to be combined with devices for exhausting the air and for introducing a gas into the said receivers, as and for the purposes set forth. (2) In an apparatus for electrically heating and testing carbon conductors for incandescent lamps, the combination, with main tube G and horizontal tube A, of the several bulbs B B, closed by plugs



or stoppers containing the conducting wires D D, carrying clamps for retaining the ends of carbon conductors, as and for the purposes described.

252,364. ELECTRIC LAMP, *Moses G. Farmer, Newport, R.I.*—*Filed May 26th*, 1881.

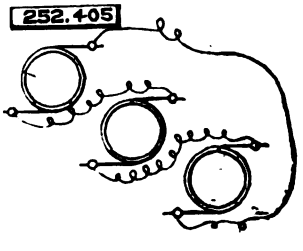
Claim.—The globe mounted in the socket, in combination with the carbon A, contained in said globe, the wires B and B^1, connected at one end to said carbon, the metallic ring D, connected to



the other end of the wire B, the pin E, connected to the wire B^1, the stand C, provided with one or more springs F F^1, and one or more springs G G^1, and the wires I I^1 and J J^1 all arranged and adapted to operate substantially as and for the purposes described.

252,405. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES, *Addison G. Waterhouse, New York, N.Y., assignor to the United States Electric Lighting Company, same place.*—*Filed April 2nd*, 1881.

Brief.—The rings are formed of two sections or plates, to which the ends of the armature coils are connected, one of the plates extending more



than half way around the commutator, whereby the armature coil connected with each ring is short-circuited while passing the neutral point. As a modification, the plates are made of equal length, and the brushes so arranged as to be in contact with a single plate during a portion of the revolution for the same purpose.

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SLIP

NEW COMPANY.—The Union Electric Light and Power Company has been formed, with a capital of £25,000.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 14th inst. amounted to £2,948.

NEW TELEGRAPH OFFICE IN PARIS.—No less than 7,000 Callaud cells, large size, are fitted up in the basement of the new central telegraph office at Paris.

CHICAGO.—American news says that the Western Union Telegraph Company has absorbed the Metropolitan Telegraph Company of Chicago, with its 125 local offices and 100 miles of line.

EASTERN EXTENSION TELEGRAPH COMPANY.—This Company notify that the coupon on their Five per Cent. Manila debentures, due May 1, will be paid on and after that date at the Consolidated Bank.

ELECTRIC LIGHT ON TROOPSHIPS.—It is stated that the electric light is to be tried on board an Indian troopship, with a view to its introduction for the illumination of the decks and saloons of these vessels.

PRIVATE ELECTRIC LIGHTING BILLS.—The Anglo-American Brush Electric Light Corporation and the British Electric Light Company's Bills were read a second time in the House of Commons on Monday.

THE BOILING POINT OF ZINC.—M. J. Violle, after careful experiments, has fixed the boiling point of zinc at 930 degrees. This agrees very closely with the experiments of M. Becquerel, who gave 932 degrees as the figure.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 14th inst. were £1,903, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE TELEPHONE IN EGYPT.—Mr. John Pender, M.P., chairman of the Oriental Telephone Company, has received the following telegram from the Khedive of Egypt:—"Congratulate Company upon opening Cairo Exchange, wishing Company success."

THE DIRECT UNITED STATES CABLE COMPANY.—The Board of this company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of five per cent. per annum for the quarter ending 31st March, 1882, payable on and after the 16th May next.

ELECTRIC LIGHT FOR MATCHING COLOURS.—The electric light has for some time past been in use at the drapery establishment of Messrs. Duff and Rowntree, of Bishop Auckland, Durham, and it is found that colours can be matched as easily by the new light as they can by daylight.

THE CHINESE TELEGRAPHS.—A special telegram, dated from Berlin last Wednesday, states that the Chinese Government have entrusted the construction of the telegraphic lines in China to German firms. The temporary despatch of German telegraph operators to China is therefore probable.

THE TELEPHONE FOR MEXICO.—The Mexican Telephone Company has been formed in New York with a capital of 1,000,000 dollars. It has acquired all the rights relating to telephones in Mexico from the American Bell Telephone Company, the Continental Telephone Company, and the Mexican National Bell Telephone Company.

ELECTRIC LIGHT IN GLASGOW.—The Salterscroft Graving Dock at Govan is being lighted by Messrs. Crompton and Co., as an experiment, pending the report of the committee appointed by the Clyde Navigation Trustees to inquire into the working of the electric light in those harbours and ports of the United Kingdom in which it is in use.

PROFESSORS AYRTON AND PERRY.—The *Graphic* of the 22nd inst. reproduces photographs of these well-known electricians, with short accounts of their public lives. The likenesses in both cases are excellent. Our contemporary also publishes an illustration of the electrical railway, the joint invention of Professors Ayrton and Perry, which was recently described in our pages.

THE HAMMOND COMPANY ELECTRICAL ENGINEERING COLLEGE.—The Hammond Electric Light and Power Company propose to take a limited number of premium apprentices, and to provide for their instruction, intending to establish a College where electrical engineering may be taught. It is intended to open the College on the 1st July. The fee for two years' apprenticeship is 200 guineas.

AURORÆ IN SWITZERLAND.—A telegram to the *Daily News*, dated Geneva, Friday night, the 22nd inst., says:—"A slight earthquake shock was felt here yesterday, and a smart one on Monday in the Vaudois and Jura. On both these days the telegraphic wires here were affected by the aurora borealis, which produced a violent oscillation of the needles. Similar perturbations were observed at other stations.

METROPOLITAN BOARD OF WORKS AND THE NEW BILL.—A report has been presented to this Board by its Parliamentary Committee, which, after giving an abstract of the provisions of the Bill, concludes as follows:—"It appears to your Committee that the provisions of the Bill are calculated to protect the public interests in the matter of electric lighting, and that they are such as the Board will approve."

THE SOUTH AFRICAN CABLE.—The Eastern Telegraph Company announces that the steamship "Great Northern" repaired this cable on Tuesday last. It was broken on the 7th of April, the fault being found to be 323 miles from Zanzibar, and in 500 fathoms of water. The "Great Northern" recovered the cable at the first attempt, but rough weather prevented a splice being made at once, and the ends had to be buoyed.

EXHIBITION OF GAS AND ELECTRICAL APPARATUS AT GLASGOW.—The reports relating to this exhibition, which was held at Glasgow in September and October, 1880, under the auspices of the Glasgow Philosophical Society, have just been published. The portion relating to electric lighting and other electrical apparatus is very small, including, as it does, only seven pages. As the reports were published by us some time since, there is no need to allude to them further now.

NEW COMPANY.—The formation of the Brush Electric Light and Power Company of Scotland (Limited) is announced, with a capital of £300,000, of which one-half, represented by 30,000 shares of £5 each, will be first issued. The Company has secured from the Anglo-American Brush Electric Light Corporation the exclusive right to use their machines and lamps, including the Lane-Fox incandescent lamp, over the whole of Scotland, paying for these concessions £15,000 in cash and £40,000 in fully-paid shares.

DEATH OF MR. CHARLES HOCKIN.—We deeply regret to have to announce the death of this eminent electrician which took place on Tuesday night last. Mr. Hockin was a Senior Wrangler at Cambridge, and his career has more than borne out its early promise. The loss which electrical science has

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thus sustained, especially in relation to the construction and laying of cables, is almost irreparable, and Mr. Hockin will be personally lamented by all who had the good fortune to make acquaintance with his unassuming but sterling character. He was a partner in the firm of Clark, Forde, and Co.

Crystal Palace.—At a lecture delivered at the Crystal Palace on Wednesday evening on the apparatus and systems employed by the British Electric Light Company, Mr. Bright stated that the project of an electric railway, thirty-six miles in length, was in process of organisation. It is to be made in a district of the south of England in which there are abundance of streams and old mills, the water-power of which will be employed to drive the Gramme-machines by which the trains will be worked. On the same evening another lecture on electric lighting was delivered by Mr. Alexander Siemens, of the firm of Messrs. Siemens Bros.

Effect of the Electric Light on Pictures.—M. Decaux has studied the resistance of colours fixed on tissues to agencies tending to alter them when submitted to their action. With reference to the electric light, he finds that its effect on colours fixed in wool by a dyeing process, as well as those of water and oil paintings, is similar to that of day light, but less energetic according to the means employed to produce it. In his experiments the colours were exposed for 1,500 hours to the light of a voltaic arc of 200 candle-power at a distance of 1·50 metres under thin glass. The effect was about four times weaker than that of the sun's light.

Telegraph Construction and Maintenance Company.—This company give notice that the fourteenth distribution on the certificates of the second bonus trust, issued under the trust deed of the 12th March, 1875, will be made on and after the 1st May. The distribution will be at the rate of 11d. per £5 certificate, payable two clear days after presentation of Coupon No. 14 at Messrs. Barclay, Bevan, and Co's. Bank, No. 54, Lombard-street; and also that all certificate holders who have not received the return of capital at the rate of £2 10s. per £5 certificate, declared in August last, can obtain payment on lodging the certificates at the above-named bank.

Proposed Electric Railway under the Thames.—The South Eastern Railway Company have withdrawn their opposition to the underground electric railway which it is proposed to construct from Charing-cross, at a point near the north-west end of Northumberland-avenue, passing under the river Thames, and terminating at Vine-street, under the loop-line station of the Waterloo terminus of the London and South Western Railway. A Bill authorising the incorporation of a company for the construction of the line was passed by a select committee of the House of Commons, consisting of Mr. Wyndham, Mr. Dundas, Mr. Lea, and Mr. Tyssen-Amherst early in the week.

Electrified Wine.—We learn that experiments have been made as to the effect of electricity on wines. The two electrodes of a battery having been placed in a flask of wine, it was noticed, it seems, that the wine became more mellow, in fact, had a better flavour. This was most particularly noticed with hard and acid wines. Electricity acts on the wines in an analogous way to heat, that is to say, it mellows them, they become older by the decomposition of the bitartrate of potash. We know that electricity is already used to rectify alcohols. We await the result of further experiments before forming any opinion on this subject, the news concerning which we publish under reserve.—*La Nature.*

Underground Wires in New York.—The introduction of a Bill making it compulsory that wires shall be laid underground in the cities of New York State has resulted in the appointment of a sub-committee, to sit in New York, for the purpose of obtaining evidence as to the possibility of working wires underground. Several eminent men, such as Mr. David Brooks, of Philadelphia, Mr. T. A. Edison, and Mr. Pope, general manager of the Mutual District Telegraph Company in New York, have been examined, and given evidence as to the feasibility of the project. One witness is reported to have said that the supply of gutta percha from Brazil would be exhausted in thirty years.

The Electric Lighting Bill.—The Committee of Selection have added the following six members to the Select Committee on the Electric Lighting Bill, in addition to the nine already nominated by the House of Commons, whose names were notified in our last issue, viz.:—Mr. Mitchell Henry, Sir James M'Garel-Hogg, Mr. Alderman M'Arthur (Lambeth), Mr. Story Maskelyne, Mr. Puleston, and Mr. Edward Stanhope. At a meeting of the committee on Wednesday Mr. Stanhope was elected chairman. Sir J. M'Garel-Hogg represents the Metropolitan Board of Works, and Mr. M'Arthur the City. The next meeting of the committee is fixed for Tuesday, the 9th May, after which they will sit from day to day except on Wednesdays.

A Long Telephone Line.—The Otago *Daily Times* of a recent date publishes the following paragraph:—"The telephone system is gradually coming into use all over the colony. The longest line we have yet heard of in New Zealand is Messrs. Cunningham and Co.'s, from Christchurch to Timaru, which has been successfully in operation for two or three months, and is likely to be extended to Oamaru. The wire to Timaru cost £1,500. Conversation is carried on with great ease, and during the grain season a great saving of time results." New Zealand may be congratulated on the enterprise of its inhabitants. The distance from Christchurch to Timaru is 100 miles. It is doubtful if any private firm in Great Britain has spent £1,500 on telephonic communication.

Proposed Standard Wire Gauge.—At the last meeting of the Wolverhampton Chamber of Commerce a circular was received from the Board of Trade, stating that, in consequence of representations made to them, they were disposed to recommend that a standard wire gauge, a copy of which accompanied the communication, should be made and verified in the Weights and Measures Act, 1878, and the board asked for the opinion of the council on the subject. Mr. Neve, a member of the Chamber, who had examined the proposed gauge, said he found that it was identical with the standard gauge proposed by the Wire Gauge Committee of the Associated Chambers of Commerce. The secretary was instructed to reply that the council most thoroughly agreed with the proposal to establish such a gauge.

Auroræ in America.—A telegram from the correspondent of the *Standard* in New York, dated Friday night, April 22nd, gives some additional information to that published in our last issue with reference to the appearance of the aurora in America. The telegram says:—"Aurora is seen almost nightly. To-night's was scarcely inferior to that of Sunday. Flowing waves of light, rushing rockets, and swaying curtains filled half of the sky. Stars were visible as through comets' tails. Bands of brilliancy, horizontal and upright, appeared, sometimes darting and wavering as though brushed by the wind and as if sound must be heard, though there was a total silence which seemed startling and mysterious. There have been violent thunderstorms and electrical disturbances, interruption of cable and telegraphic communication."

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THE PROPAGATION OF ELECTRICITY.—At a recent meeting of the French Physical Society, M. Mascart showed some experiments by means of which he could demonstrate to an audience the theory of the propagation of electricity in a variable state. A medium conductor is attached by one end to an insulated support, and by the other to earth. The insulated end can be connected, during a shorter or longer time, either with earth or with a constant source of electricity, positive or negative, represented by one or other of the covers of a Leyden jar. By means of a movable contact piece the conductor at a certain point is connected with a gold leaf electroscope, or, better still, with a mirror electrometer. By this means the phenomena taking place in the conductor by the passage of an electrical flow, or several successive flows of different signs, can be shown to an audience.

NEW AMERICAN CABLES.—A correspondent of the *Operator* says:—"Superintendent J. W. Plaisted, of the Western Union Telegraph Company, returned to this city (Portland, Me.), 8th inst., having completed the temporary laying of the new American cables in the land trench from Canso, N.S., to Dover Bay. Mr. Plaisted had matters well arranged. With a flotilla of three vessels and a powerful tug he met the cable steamer "Faraday" before she came to anchor off Dover Bay, and, in two hours' time, had the large drums containing the twenty-eight miles of heavy shore-end cable landed. Each section of seven miles of cable was carefully strung out upon the shoulders of 250 men and deposited in the trench. The rapid work of laying those four heavy cables in a seven-mile trench through woods, ledges, and bogs, astonished the English electricians, who came over with the cable."

ELECTRIC SEARCH LIGHTS.—The Brush Electric Light Company recently fitted a powerful search light on board the Argentine ironclad "Almirante Brown." As evidence of its power and utility, the following extract from a letter they have received from one of the officers in Buenos Ayres may be quoted:—"We have used the light a good many times, and have found it very satisfactory. Some of the other ironclads have been laying down here, and we have used the light for signal purposes, first hoisting our flags and throwing the light on them, and then turning the light on the other ships and observing their flags. Of course the light would be useless for this purpose were we not able to absolutely distinguish colours by it. We are laying six miles off the shore, and at a house two miles inland it is possible to read small print by our light. At first the people thought it was a new kind of comet, and predicted another revolution and all sorts of misfortune for the country."

ELECTRIC LIGHT AT WINDSOR CASTLE.—Portions of Windsor Castle were lit up on the occasion of Prince Leopold's marriage with Princess Helen of Waldeck, and this is the first time, we believe, it has been seen at Windsor. A Crompton arc lamp was placed on the summit of the flagstaff tower of the round tower, from which it could be seen for many miles round. The steam engine and Bürgin dynamo-machine were placed on the north terrace, between the Winchester Tower and the library, whence the wires were carried up the staircase of the round tower to the bottom of the shaft near the great Sebastopol Hill, and thence to the roof of the flagstaff tower. Maxim incandescent lamps also were placed round the quadrangle, the latter being supplied by the Electric Light and Power Generator Company. On Wednesday night the Crompton light was started, the King and Queen of the Netherlands, the Royal Family, and other guests coming out to witness the effect, which was very fine.

ELECTRICAL EXHIBITION AT MUNICH.—An Electrical Exhibition is to be held in the Palais Royal at Munich. A Committee of Organisation has been formed, with Dr. G. de Beetz, Professor at the Royal Science School, at its head. The Exhibition is to open on the 16th September next, and continue till the 8th October, or till the 15th October, if judged convenient. Intending exhibitors must send in notice of their requirements in a form to be obtained of the "Committee for Electro-Technical Experiments in the Royal Exhibition Palace, Munich," and must be returned to them not later than the 1st June next. The latest time for the delivery of goods is fixed for the 9th September, and all installations must be complete by the 14th Sepetember. No awards will be made, but every exhibitor placing his goods at the disposal of the committee for technical and scientific testing, will have the right to demand a certificate as to the results, provided such testing has taken place. It may be added that fire insurance within the limits of the Palace will be defrayed by the committee.

CRITICISM ON THE ELECTRIC LIGHTING BILL.—A "Chairman of a Local Board" writes to *The Times*, pointing out that there is a remarkable omission in the clause relating to provisional orders. He says:—"The Board of Trade may authorise by provisional order any 'local authority, company, or person,' to supply electricity within 'any area.' Then follows an important provision that the local authority, within whose jurisdiction such area or any part thereof is situated, may at the end of seven years require such 'company or person' (omitting here the term 'local authority') to sell to them their undertaking at a price to be settled in cases of difference by arbitration. The effect of this provision as it now stands will be that, if the Manchester Corporation or any other local authority once succeed in obtaining powers to supply electricity in a district outside their general jurisdiction, these powers will be perpetual . . . It behoves all local authorities who are so situated as to be liable to the establishment of a permanent monopoly in their respective districts to bestir themselves."

HILL'S GRAVITY CELLS.—Dr. B. Baynes, writing on the physiological action of electricity in the *Homœopathic Review*, says:—"The elements I usually employ for stationary batteries are Hill's Gravity Cells. They are very inexpensive, and work well for a long time with little, if any, attention. The element consists of a glass or earthenware cell, circular in shape; at the bottom is placed a roll of copper, covered with crystals of sulphate of copper; water is added till the cell is one third full. A saturated solution of sulphate of zinc is carefully poured over this till the cell is about two thirds full; suspended from the top of the cell, and just touching the upper solution, is a zinc disc, usually made with a large aperture in the centre. The only attention necessary is occasionally to add a little water, to replace any loss by evaporation; a layer of paraffin covering the zinc solution will almost entirely prevent any loss from this cause. The solutions of sulphate of zinc and copper are kept apart by the difference in their specific gravities. Care must be taken not to shake the cells, or the solutions will become mixed."

LEGAL.—UNITED TELEPHONE COMPANY v. HARRISON, COX-WALKER, AND COMPANY.—This case has been heard before Mr. Justice Fry in the Chancery Division of the High Court of Justice during the week. It is an action to maintain the plaintiff Company's patent rights, they asserting that the defendants have sold telephones which, so far as the transmitter is concerned, infringe Bell's patent, and so far as the receiver is concerned, that of Edison, both of which patents

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are the property of the Company. Amongst the witnesses examined have been Sir Frederick Bramwell and Sir William Thomson. The defence is much the same as that put forward in the recent trial at Edinburgh, viz., that Bell's instrument was described in an embryo state by Sir William Thomson at Glasgow, prior to the patent being taken out, and that Edison's patent was anticipated by Reis. We shall hope to give a fuller account in a further issue. At present, however, we are too much pressed for space. For the plaintiffs there appeared Mr. Aston, Q.C., Mr. Webster, Q.C., Mr. Cozens-Hardy, Q.C., and Mr. Moulton, F.R.S.; for the defendants, Mr. J. Pearson, Q.C., Mr. Hemming, Q.C., Mr. Goodeve, and Mr. F. L. Muirhead.

The Brush Light in Cleveland (Ohio).—We are informed that the Brush Electric Company of Cleveland now have three masts in operation in the central part of that city, one 250ft. and two others 200ft. in height respectively. The effect of the eight 4,000 candle-power lamps surmounting each of these masts has been so satisfactory in every way as to induce the City Council to accept the three masts already erected and to contract for the erection of two more. In addition to these masts the Council has directed the illumination of two miles of Euclid-avenue, and two miles of Prospect-street, by means of the electric light on posts. The company purpose soon to begin the erection of the additional two masts proposed, and will erect the posts along the thoroughfares named as soon as there is sufficient money in the lighting fund to carry out this part of the contract. There have been several resolutions proposed in the Council as to the erection of electric light masts in other parts of the city, and it is thought that the time is not far distant when the electric light will entirely supersede gas for the streets and parks of Cleveland. The mast system already meets with great favour from the people and the press of Cleveland.

The German Union Company's New Cable.—The new cable laid by the German Union Telegraph Company from Emden to Valentia, in Ireland, where it joins one of the Anglo-American Company's cables, was formally opened for traffic on the 22nd instant by Dr. Stephan, the head of the Imperial Postal Department. The traffic was inaugurated by a message from the German Emperor to President Arthur, to which the latter immediately replied in terms of the warmest sympathy. The text of President Arthur's telegram, translated into English, is thus given by *The Times* Berlin correspondent:—"I have received the first despatch over the new line of telegraph between Germany and the United States—namely, Your Majesty's kind message—with much satisfaction, in common with all the people of the United States, so many of whom still speak the German tongue in their homes. I share in the pleasure which Your Majesty expresses at the opening of this new line of communication, and in the hopes that it will serve to promote the friendly relations which we desire, and which it will be my aim to preserve and increase." The transmission of this telegram from Washington to Emden only occupied $5\frac{1}{2}$ minutes.

Electric Light at Birmingham.—At a ball given at the Plough and Harrow Hotel, at Edgbaston, a suburb of Birmingham, on Friday week, the room was lighted by means of Swan lamps. The lamps and apparatus were supplied by Messrs. R. W. Winfield and Co., and were erected under the superintendence of Mr. Henry Lea, C.E. The installation consisted of a Bürgin dynamo machine, driven by a portable steam engine, enclosed in a temporary wooden shed, erected at the bottom of the hotel garden. Cables were led from the dynamo machine into and around the ball room and drawing room, and were concealed in horizontal hollow-brass rods, fixed to the walls immediately under the cornice of the rooms. From the hollow rods hung fifteen ornamental pendants, specially made for the occasion, each pendant having two simple scroll arms carrying one Swan incandescent lamp on each arm. Each Swan lamp was surmounted by a fluted saucer-like shade of Venetian glass. Six additional pendants of a more simple form were suspended from the soffit of a wide doorway separating the ball room from the drawing room. The light was bright and steady, and the rooms are said to have been remarkably cool and pleasant during the whole of the evening.

The Telephone in Belgium.—According to the copy of the conditions attached to the concession to the Compagnie du Téléphone Bell, which is now before the Belgian Parliament, the concession will last for twenty-five years. No subscriber is to be connected to the company's office before all particulars as to his name, residence, and other details have been furnished to the Minister of the Interior, and his authority for the work obtained. All wires are to be placed underground; those, however, that are already erected overhead may be used by the company for the next five years, at its own risk. At the end of that time they also must be placed underground. The annual subscription is never to be more than 300 francs within a radius of two kilometers, but 50 francs can be charged for every kilometer outside this radius. Public offices may be opened, at which a charge of 50 centimes may be made for ten minutes' conversation or under. The State is to receive 10 per cent. of the nett receipts, and the annual sum so paid must never be less than 2,000 francs per annum. A deposit of 20,000 francs has been made by the company with the State as security, and this sum will only be returned at the end of the term for which the concession lasts, or on the buying in of the concession by the State. At the end of the term all instruments, lines, &c., shall be handed over to the State absolutely free of charge. Many other somewhat stringent clauses are contained in the conditions.

Municipal Corporations and the Electric Lighting Bill.—The Electric Lighting Bill was discussed on Thursday week by the council of the Association of Municipal Corporations, at their offices in Westminster. Sir James Picton, of Liverpool, presided. After a long and animated discussion, it was resolved to memorialise the President of the Board of Trade for the adoption in his Bill of the following amendments, viz.:—(1) No application for a license or provisional order under this Act shall be made in respect of all or any part of any district of gas supply of a local authority without three months' notice to such local authority, who shall be entitled within that period to make application for a license or provisional order; and until such application has been disposed of no other application shall be made or entertained. (2) No application for a license or provisional order on the part of any company or person shall be made in respect of all or any part of the district of a local authority without three months' notice to such local authority, who shall within that period be entitled to make application for a license or provisional order; and until such application has been disposed of no other application shall be made or entertained. (3) No powers of public lighting now vested in the local authority in relation to streets shall be interfered with or affected by any provisional order, except by agreement with the local authority. (4) That no electric lines or overhead works across or over streets be authorised by any provisional order without the consent of the local authority.

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ELECTRIC LIGHTING IN GLASGOW UNIVERSITY.

BY J. T. BOTTOMLEY.

Within the last six months Sir William Thomson has been making a commencement of electric lighting with Swan and Edison incandescent lamps in his house in Glasgow University, and in the Physical Laboratory and some of the class rooms. The arrangements for the lighting of his dwelling-house may now be said to be approaching completeness, and there are a few points in connection with his system which will probably be interesting to the readers of *The Electrician*.

Sir William Thomson employs for the installation on its present scale a six horse-power gas engine of a new type by Mr. D. Clerk, of Glasgow (described to the Institution of Civil Engineers a few weeks ago), a Siemens shunt dynamo, ($S D_2$), 40 triple cells of Faure's secondary battery of the old type of last May, together with instruments which I shall briefly describe.

The gas engine, dynamo, and Faure battery are placed in the physical laboratory, and in a room adjoining to it; and are carried through the Natural Philosophy class room, and very heavy mains of "conductivity" copper wire, No. 0 B.W.G., thence on through the Mathematical and Engineering class rooms, which it is hoped will also have the benefit of electric lighting by next session. From the class room the mains are carried through the air, a distance of about 100 yards, to Sir William Thomson's house. The Swan lamps are incandesced in pairs, two in series, a branch being taken from the main wire *for each pair;* and the potential on the two sides of each pair is kept at 80 volts. Each pair can be lighted and extinguished separately. The Edison eight-candle lamps are placed single in each bridge, but with a resistance connected with each to enable it to bear the high potential applied to the *pair* of Swan lamps. The current coming to the house is regulated by an instrument which I may perhaps describe at another time; and the brightness of the lamps in some of the rooms is regulated independently by similar instruments.

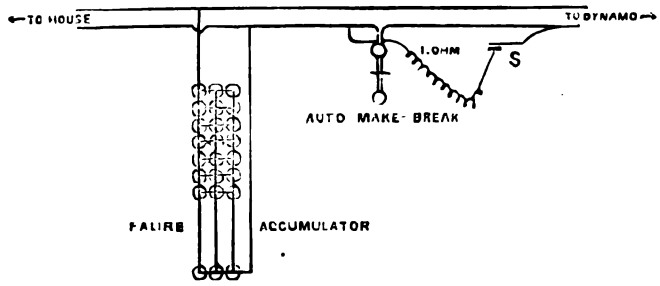

FIG. 1.—Diagram showing connections from Dynamo to Accumulator. Note.—"Auto Make-Break" should be Automatic Make-Break.

The part of the system which I wish more particularly to describe at present is a novel use of the shunt dynamo, worked as a motor by the accumulator, for starting the gas engine.

The diagram, Fig. 1, shows the connections. The dynamo, driven by the gas engine, sends the current through the mains to the house. The Faure battery is attached to the mains in a derived circuit on the house wires. When the dynamo is going at full speed, and when there are no lamps in use in the house, the whole of the current goes through the accumulator, and charges it. When a small number of lamps are being used in the house, and the dynamo is going at full speed, the current divides, and part of it goes through the lamps and part through the accumulator. Under these circumstances, the accumulator proves a valuable regulator for the current, keeping the lights much more steady than they would otherwise be. It forms a reservoir which is ready to receive *much* more or *much* less of the current when the unsteadiness of the engine causes the dynamo to go *a little faster* or *a little slower* than the average. When a larger number of lamps are being used, the dynamo and accumulator both contribute to the required current. Lastly, when the dynamo is stopped the current from the accumulator is ready to act by itself. The accumulator is used late in the evening, when the engine is thrown off, and before the engine is started for its night's work, and for illuminating dark places in the house during the daytime.

One difficulty and danger which requires to be guarded against in the use of an accumulator with a dynamo-electric machine is the danger of the current being sent backwards through the dynamo in case of the engine going too slow or suddenly stopping. In charging accumulators with a dynamo of the ordinary type, in which the moving coils and electro-magnets form part of the same circuit, this is most serious; for if the current flows back the dynamo becomes reversed in its action; and if the engine goes on again and

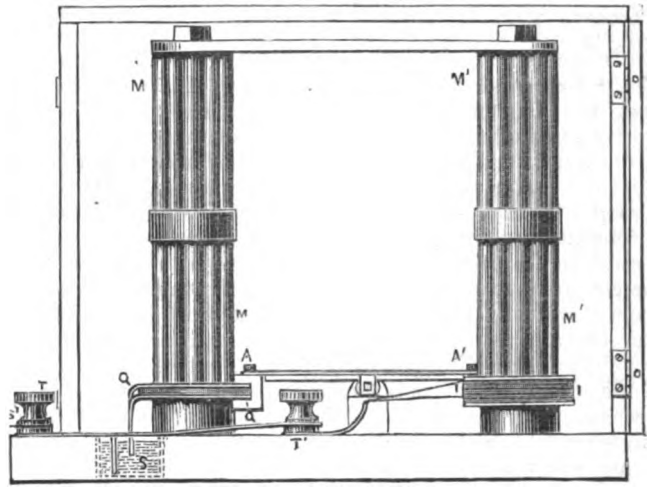

FIG. 2.—Automatic Make-Break (elevation).

increases in speed the current, which ought to be in the direction for charging, is maintained with increasing force in the reverse direction. This is not the case with the shunt dynamo; but even with it there is or may be danger of a current too powerful for the coils being sent through the dynamo by the battery if the dynamo should stop.

To do away with this danger Sir William Thomson uses the Automatic Make-Break, which is shown in the diagrams Figs. 2 and 3, and of which the following description is taken from his patent "For Improvement in Regulating Electric Currents, and in the Apparatus or Means employed therein."

The make-break, which is represented in elevation in Fig. 2, and in plan with the magnets in section in Fig. 3, consists of a stiff bar, A, A^1, like the beam of a balance carrying on one end a circular coil, I, of a great length of fine insulated copper wire, and on the other end a single circle or a circular coil, of a short length of thick copper wire, Q, the planes of these coils I and Q passing through the pivot-axis or line of knife-edges of the beams,

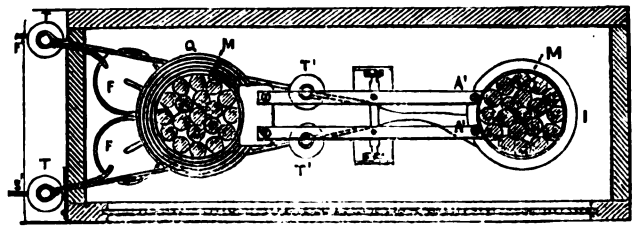

FIG. 3.—Automatic Make-Break (plan). Note.—The lower F should be S.

A, A^1. The ends of the coil I are connected with two cups of mercury, S, F, by fine wires properly placed, to afford the requisite freedom of motion to the beam. The ends of the coil Q are connected by thick copper wire with pieces of thick platinum or copper wire dipping into the mercury in the cups S and F, which are so placed that when the beam tilts Q up, one or both of the platinums is drawn out of the mercury. The cup S is connected to one pole of the source by the thick wire S^1, and the cup F is connected by the thick wire F^1 to the corresponding pole of the accumulator, the said wires dipping into the mercury in the

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said cups. The other poles of source and accumulator are permanently connected with one another by thick wire. Fixed steel magnets M, M^1, are so placed in the neighbourhood of I and Q as to cause the beam A A^1 to tilt Q down when there is a current through I in the proper direction, so as by this tilting to make a circuit through the mercury cups and the said coil Q, and to keep it down in virtue of the current through Q when the mercury contact is made. The beam A A^1 is so balanced that should the charging current at any time cease, Q shall be tilted up, and one or both of the mercury contacts broken. Should the current become reversed very suddenly through sudden stoppage or slowing of the charging dynamo or other accident, the magnets acting on Q accelerate the tilting motion. The length and fineness of the wire of I must be such that the current backing through it, when the electromotive force of the source falls short of that of the accumulator, is not enough to make any serious loss from the accumulator or to damage the source." To guard against possible damage to the source through accidental failure of the automatic make-break, or because of its not acting quickly enough in the event of a sudden stoppage or diminution of the electromotive force of the source, or through accidental short-circuiting of the accumulator, a short length of wire, fine enough to melt before damage can be done by any current in either direction through it, is sometimes introduced in one of the electrodes between source and accumulator. Or a second electro-magnetic make-break may be used with a single movable coil acting just as does the coil Q, but weighted so as to be tilted up and to break circuit when the current exceeds a certain limit, and to make again when the electromotive force has fallen sufficiently to give not too strong a current. T T represent terminals.

The last point that I shall touch upon is the very interesting one of the starting of the gas-engine by means of the Faure battery and dynamo. One great trouble of gas-engines, as constructed at present, is the trouble of starting them. The fly-wheel requires to be pulled round rapidly two or three, or half a dozen times before the first explosion takes place; and after a single explosion has taken place it is often necessary to continue the turning of the fly-wheel for some time, on account of the liability of the cylinder to get choked with a mixture of gas and air, too rich in one or other of the ingredients to form a proper explosive mixture. This for an engine of six or ten horse-power is very hard and very trying work, owing to the necessity for turning the heavy fly-wheel, and working against the compression stroke of the modern gas-engine, at high speed.

Sir William Thomson has done away with this labour by using the Faure battery and the shunt dynamo for starting the engine. When the current is allowed to flow from the battery through the shunt-dynamo, the effect is, as compared with the dynamo kept in motion by the engine, that the direction of the current in the electro-magnet remains *the same*, while that of the armature coils is *reversed;* and thus the armature coils, with the current from the battery, turn in the same* direction as that in which the engine when in action causes them to turn. The engine, connected with the dynamo by the belt, is, therefore, itself turned in the proper direction for starting; and the gas stop-cock being opened, and the ignition flame lighted, the engine is kept going till the first explosions are produced. After that the engine works in the usual way, the speed increasing till, after a few seconds, the Faure battery is overpowered by the dynamo, and the current is sent through the battery in the direction for proper charging.

The arrangements for producing this effect are shown in Fig. 1. When the dynamo and engine are stopped the coil Q of the automatic break is up and the accumulator is cut off from the dynamo. But at S there is a hand make-break, by means of which direct connection can be made between the dynamo and the accumulator, the automatic break being short circuited. A resistance of an ohm or two is introduced as shown to prevent too much flashing on the commutator bars and too strong a current from the accumulator through the coils of the dynamo. With this arrangement all that is necessary in order to start the engine is first to light the igniter flame, then make the contact S. Immediately the dynamo starts. Now turn on the gas supply. One or two explosions take place, and the engine is fairly started. Then break at S. Soon the engine gathers speed, and the dynamo overpowers the Faure battery current; the coil Q is tilted down, and the short connection established between the dynamo and the battery.

* This would not be the case with an ordinary self-excited dynamo. In it the current is reversed *both* in the coils and in the magnet.

THE CRYSTAL PALACE EXHIBITION.

Rogers' Railway Station Indicator.

We have already described the needle instrument exhibited by Mr. Rogers. Another of his exhibits is a station indicator, adapted for such lines as the Metropolitan and District, where the carriages are permanently coupled. This indicator is intended to be placed within the carriages to show the station towards which the train is approaching. Each compartment in the train contains a dial something like a clock dial, but instead of figures indicating minutes or hours, the names of the successive stations are given radiating from the centre. The pointer can move round the dial as required, and is actuated by an electric current. The method suggested for completing the circuit is to have an arm under the step of the

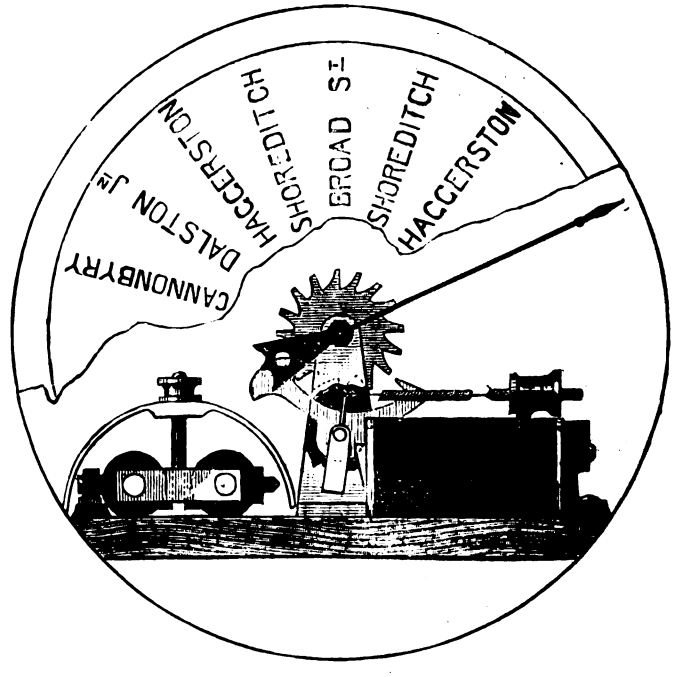

Fig. 1.—Rogers' Station Indicator.

first carriage, which, when the train enters a station, strikes against a peg fixed to the platform or otherwise. Contact is thus made, a current sent through the apparatus, and the pointer moved to the position required. Credit is claimed for this automatic method of making contact, but we think that it would be preferable to rely upon the guard for making the necessary contacts. No doubt the companies will ultimately consider the convenience of the travelling public, and adopt some such system as this, which is urgently required upon most of the Metropolitan local lines. Among his other exhibits Mr. Rogers shows his "carbon contact." It is well known by electricians that where a current of any quantity is used there is a tendency for relay tongues to stick, and this is particularly so with fast working instruments. Mr. Rogers says:—"A long series of experiments upon this subject showed me very clearly that the most delicate relay may be made quite reliable by using platinum upon the tongue

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and a special form of carbon upon the striking pin, or contact, each contact whether giving a perceptible spark or not,

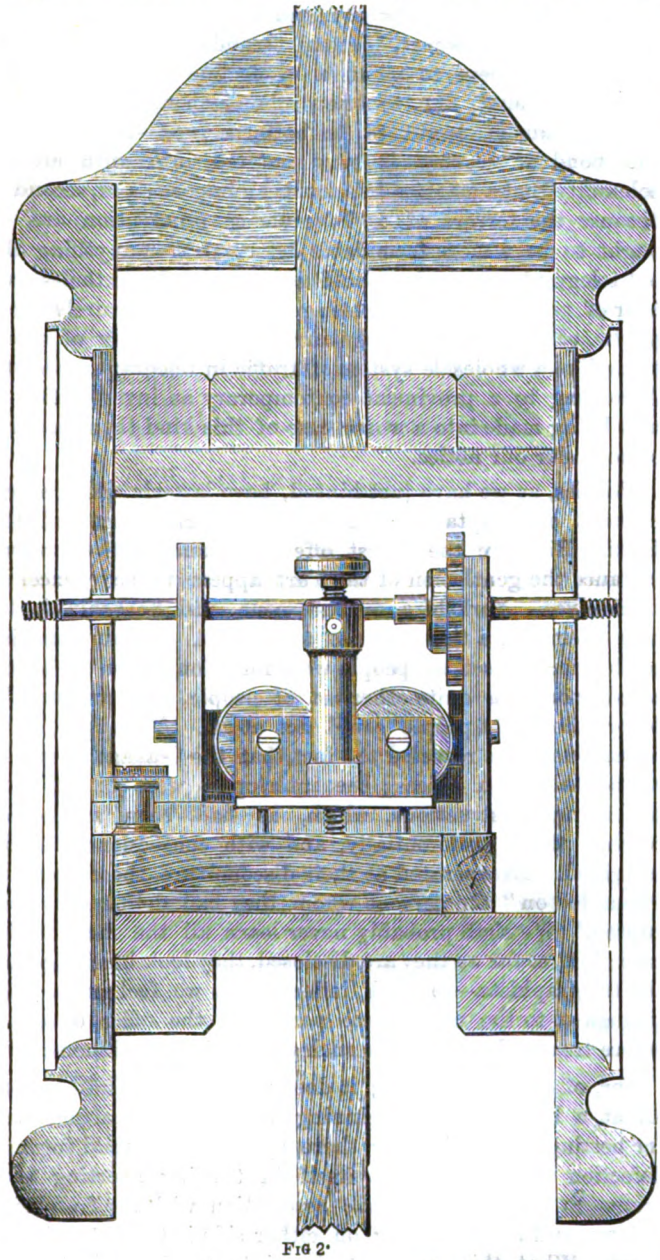

Fig 2.

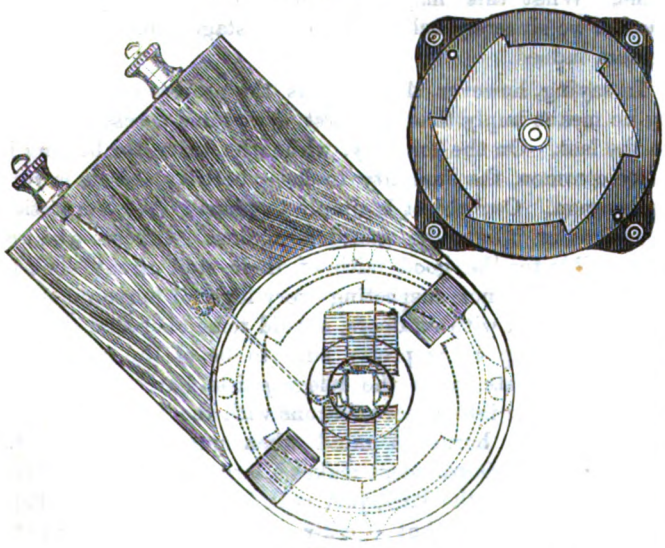

Fig. 3.

decomposes a minute portion of the carbon, converting it into CO_2. Thus, a fresh surface is exposed at each stroke, and so a perfectly clean contact is ensured. The arrangement may be set with a degree of fineness which no ordinary relay admits of, and is quite reliable. It is specially suited for long lines, and the carbon plugs can be inserted into many classes of instruments at a nominal cost." Mr. Rogers also shows a mounting table for microscopic objects worked by the current, which will be understood from the illustration.

The United Asbestos Company.

A goodly display of asbestos is shown by this company in their stand in the gallery. It is but recently that any attempt has been made to use asbestos in electrical work, but its manufacture in various directions applicable to electric light work is now being rapidly developed. Methods have been devised so as to cover wire with the material, and as it is a good insulator and incombustible, it possesses two valuable properties in the eyes of the electric light engineer. Those who have seen the insulation of the ordinary insulated wire "go" under too large a current will here find a material which acts quite differently. It will be said that too great a current ought not to be sent through the wire. We quite agree with this, and also that under a good engineer such a contingency would be guarded against. The material has been fashioned with hollow tubes, rendered water-tight by being covered with a waterproof composition, and it is expected that such tubes will be useful to contain the main and branch conductors from a central station. Asbestos has been used for insulation of commutators; it has been fashioned into gloves, so that those who have to handle arc carbons may do so with impunity, even when such carbons are hot with a current passing. Flat discs of the material have been made, and it is hoped that asbestos may be used instead of ebonite in the construction of many parts of electrical instruments. We have suggested that asbestos paint might with advantage be used in many cases when an insulated water-tight material is wanted. We have tested some plates of asbestos, and found the insulation to be very high indeed. We shall watch with some interest the development of the use of this material in electric light operations.

Underground Wires.—In a recent issue of *Bradstreets* is an article on the necessity for laying wires underground. Our contemporary says:—"Experiments in Germany and the United States have given fairly satisfactory results with wires conducted underground. The drawback, heretofore, to underground wires has been excessive cost and the difficulty in ascertaining where breaks are located when any occur, and the trouble and expense incurred in repairing them when found. The experiments have shown that this alleged excessive expense is largely imaginary. The first cost of laying the wires is increased, but the expense of maintaining them is lessened. Breaks from storms, other violence, or from rust, are impossible, and a very high percentage of damage to wires is caused by the agencies thus averted. The safety and convenience to the public also are no small elements." It then goes on to speak of the various accidents that have occurred in New York, and other American cities, which were due to overhead electric light and other wires. In Buffalo it appears that the wires are so numerous overhead that they are described in the local papers as the "spider web" and the "veil of wires." "Here in New York," continues *Bradstreets*, "the case is, in parts of the city, even worse. The impertinent annoyance of having to admit repairers and constructors of lines of wires to the roof of one's dwelling at any and all hours, and permit them to erect and maintain supports, at some cost to the roof, needs no elaboration to point the necessity for some other method of 'accommodating the public.' The electric wire must and will, in the not far distant future, be conducted underground, at least through cities. There is no time like the present to take so important a matter in hand."

Indo-European Telegraph.—It is stated that the average time occupied by telegraph messages from India to England, *viâ* Teheran, during the fortnight ended March 25, was forty minutes for each message.

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THE ELECTRICIAN.

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All communications to be addressed to 396, *Strand, London, W.C.*

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THE SECRESY OF TELEGRAMS.

The disclosure of the contents of Colonel Fred Burnaby's despatch on its way to Mr. Wright has reminded the public how greatly at the mercy of the telegraph administration their telegrams continue to be. In the particular case referred to probably no great harm was done, and on the whole the statement of the Postmaster-General with regard to it is not so alarming as at first sight it appeared. It may be regretted that the Government have no control over the provisions for ensuring secresy of despatch by submarine cables belonging to private or foreign companies; but the absence of such control will be felt far less on those lines than it would be on any of our local lines, for the simple reason that in a general way there is far less to divulge. Over lines where the tariff is high and at so much per word, words are sparingly used, partaking more or less of the character of cypher, and rarely intelligible to any but the correspondents themselves. Although this is the rule, however, there are, doubtless, occasional exceptions; and a choice morsel of information may now and then present itself as a temptation to the impecunious telegraphist—always assuming that he has a market for it, of which more anon. To meet this contingency the companies exact of their clerks a promise of secresy, and threaten them with penalties if they break faith,—that is to say, the public are protected in respect to non-governmental lines just as they were protected when the land lines were all non-governmental.

We believe we are justified in saying that this provision, inadequate as it may appear, was practically efficient. Instances of criminal violation of the trust reposed in the staff were almost unknown, and punishment for indiscreet incontinence of tongue had seldom to be inflicted. The men pledged themselves to secresy, and they kept their pledge. This was true thirty, twenty, and even ten years ago. In recent years, however, several scandals have come to light which seem to point to a decline in this respect, and we should like to know the reason. Theoretically, the Government ought to be better served—first, because the bond of secresy is now entered into with all the solemnity that a magistrate's court can impose; and, secondly, because the terrors of a Government prosecution are, or ought to be, a more formidable deterrent than anything the old telegraph companies could command. Nevertheless, we hear of political telegrams being somehow prematurely made public, of messengers being corrupted, and lately of something like a wholesale system of traffic in telegraphic secrets. According to a provincial contemporary an investigation is now being made into a worse case of this kind than has ever come under our notice.

Politics, as we have just hinted, have latterly added a new element of temptation; but the Stock Exchange and the Betting Ring are the oldest offenders; and in the present instance the gentlemen of the Turf appear to have excelled themselves. Yorkshire was the scene, and Yorkshire 'cuteness seems for a time to have triumphed. Instructions intended for one set of people were for a long time uniformly acted upon by a quite other set of people, and presumably before the right people could act at all. At length, some bogus telegrams revealed the fact that the leakage occurred at the telegraph offices; the interlopers were bitten with misleading instructions, which, as had been suspected, reached them preferentially, and with consequences easily imagined. Exasperated at their discomfiture, these worthies "rounded on" the persons whom they had deliberately corrupted. We shall probably never learn all the facts of the case; but, so far as they are disclosed, they look black against the telegraphists—so black, indeed, that we feel grave misgivings as to the moral tone pervading the office or offices where treason has grown to such unconscionable dimensions.

For, of course, it grows; it does not shoot up and blossom all at a bound. The beginning is a fancy for racing, then for betting; from betting there springs that mild form of defection which manifests itself in turning sporting telegrams to personal account; association with the fraternity follows, and illicit tipping on either side is the natural outcome. What this may develop into we have just seen, though we sincerely believe it to be a stage reached but very seldom indeed.

In saying, however, that this is the process of growth we by no means imply that the first symptoms necessarily lead to the last. On the contrary, while the taste for betting is quite common, the inability to keep betting secrets is very uncommon. Our object is simply to point to the temptation in order that it may be guarded against. Officers who are responsible for the good faith of their staff should look to this, and while not suspecting every lover of horse racing of communication with outdoors, should remember that if there is a black sheep he is pretty sure to be of the racing persuasion. Of late years the telegraphists have been thrown more than ever into closer relations with the Turf; and this, too, should be borne in mind when punishment is to be awarded. The Department makes a large revenue out of the national sport on the Turf, just as it does out of the perhaps not equally national, but equally disreputable sport on the Exchange. In the former we none of us feel ashamed of taking occasional interest; and as to the latter, directors

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and privileged shareholders have been known to invade the sanctity of the instrument room not exactly on official business. In such conditions it is a mockery to prohibit "gambling," and it ought never to be attempted. A young man can no more be denied the privilege of backing his favourite horse than an old man of voting for his pet politician. There is seemingly something inherently immoral about horses and polling-booths, just as there is said to be about umbrellas. We must resign ourselves to facts; we cannot alter them, and we have no business to try. All that we can or ought to do is, so to speak, to take better care of our umbrellas. The general public may gather some comfort from the fact that, in this relation, only ginghams of doubtful utility and villainous make are liable to be stolen. The superfinest of secrets is still safe over every line in the kingdom—providing there is no odour of the stable about it.

CORRESPONDENCE.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have had my attention called to your publication on the 15th inst. of what purports to be a translation of a proceeding in the French Courts brought by M. Faure against me.

That publication is false and libellous, and I feel sure you would not have inserted it had you been acquainted with the true circumstances of the case. I therefore make no further claim against you beyond the request that you publish this letter.

Mr. Philippart stated in the *Standard* newspaper that he was the author of the libel I complain of when I advertised to discover the perpetrator. At the time his letter appeared I had already discovered who was the author of the libel, and I had commenced proceedings against him and La Société Anonyme La Force et La Lumière for libel.

The case is now pending in your English courts, and I feel confident that I can not only vindicate in those tribunals my own case and honour, but I can also publish the authors of a cruel and malicious libel, circulated for the worst motives, viz., to injure an innocent man, simply because he seeks to reap the benefit of his own inventions, those inventions being prejudicial to existing interests.

All I now ask is for your readers and the public, both here and abroad, to await the determination of my case for libel, and the decision of the French courts on the case M. Faure has there brought against me.

I most certainly intend to make Mr. Philippart justify his accusations, or suffer the consequences of malicious and unprovoked calumny.—Yours, &c., E. VOLCKMAR.

43, Conduit-street, W., 26th April, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your number of the 8th inst. you publish a speech made by Mr. Sellon at a banquet which took place at the Crystal Palace. That same day I addressed a communication to him by registered letter, which you published on the 15th inst. I only received Mr. Sellon's reply on the morning of the 15th inst., and immediately answered it in the following terms:—

"I beg to acknowledge the receipt of your favour of yesterday. No more than yourself had I ever the intention of submitting the questions in dispute to a jury of amateurs.

"We would have chosen the most competent and honourable electricians of each country, and it is beyond doubt for any impartially-minded man that the decision of such a jury would have weight even with the tribunals.

"The only restriction I made was that the present judicial proceedings should not be suspended, leaving to each of us, after the decision of the jury, the option of taking proceedings spontaneously, in conformity with the sentiments of loyalty and honour which you have so well expressed.

"I regret I am unable to separate your case from that of Mr. Volckmar, but I quite understand that this individual being your partner, you wish to consider him as a perfectly honourable gentleman until the contrary shall be proved to you.

"I conform to your wish in not publishing your letter, but I reserve to myself the right of publishing mine.—Yours, &c., (Signed) S. PHILIPPART."

I do not understand how Mr. Sellon, after having withheld his consent to publish his letter, should now himself practically do so in your cloumns.

However, I quite agree with him in considering the discussion at an end for the present in this arena, but I cannot help expressing my surprise that, after having in his speech emphatically appealed to a scientific jury, and proclaimed his respect for the rights of inventors, he should now decline to submit the case to such a jury, a course I was willing to accede to, and recur to the tribunals.

On this vantage ground I have already taken our stand, and he and his partner, Volckmar, may rest assured that I shall make every effort to retain that position, and be ever ready, under all circumstances and conditions, to meet them.—Yours, &c., S. PHILIPPART,

President de la Société la Force et la Lumière.

Paris, April 25, 1882.

P.S.—Mr. Sellon makes the same mistake as the correspondent of *The Times*, in his letter, published the 9th of September, 1881, by calling him *Volckman* instead of *Volckmar*.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Dr. Shettle's letter under this heading he maintains, at least by implication, that curative powers are possessed by certain magnetic appliances. If this be *not* the case it is certain that a very large amount of delusion and money-getting deception prevails in connection with such appliances. Now, I make bold to assert, directly and confidently, that it has never yet been shown that magnetism—even as developed by the most powerful permanent or electromagnets—exerts any physiological action whatever. I should really be glad to be contradicted on this point; but, to be effective, the contradiction must be dependent upon a process of induction, and not upon the particular deductive method which is illustrated by your correspondent. Until proof as to the physiological action of magnetism be forthcoming, the testimony—even of clergymen of the highest respectability—as to cures effected by pieces of magnetised crinoline steel sewn up in flannel, or by magnetised steel filings disseminated in india rubber, must be placed on a par with that by which the claims of the vendors of "electrical" stars and lockets, *et hoc genus omne*, are supported. In the case of electricity, the physiological effects in various directions were long ago clearly established; and the curative effects thus shown to be *possible* have been verified in medical practice both in and out of hospitals. But the claims put forward, without any *primâ facie* foundation, and in opposition to all scientific experience, on behalf of *magnetism*—an agency associated with available energy only when the latter is supplied through the mechanism of magneto-electric appliances—have not only encouraged the growth of electrical shams, but have directly thrown discredit upon one of the most important applications of electricity, and upon many who have honestly endeavoured through it to alleviate human suffering. I have no doubt but that a useful "chest protector," which, by a slight stretch of language, might even be termed a "lung invigorator," may be constructed of flannel; but to claim for "magnets" enclosed in it any superiority over pieces of whalebone of similar form, or to seek to establish any analogy between its action and that of a continuous or intermittent electric current is simply to take advantage of the popular ignorance in relation to electricity and magnetism,

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and to trade most reprehensibly upon the undoubted success which has attended the scientific applications of electricity to curative purposes. To such manœuvres Dr. Shettle probably refers in his mention of the "trade aspect of the question;" but I fear that he will be quoted as an authority by many who are now profiting by them. To the latter I would intimate that the "lateral extension of science" will make their position more and more untenable; and upon their dupes I would particularly impress the aphorism that *post hoc non est propter hoc!*—Yours, &c.,

DESMOND G. FITZGERALD.

DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On March 9th of this year my father communicated to me an idea of making use of both poles of field magnets in the dynamo instead of only one. I had myself wondered some time previously why both ends were not made use of, but I dismissed all thoughts of it, and it was not until my father suggested it to me that I thought more about it, and readily joined him in reducing our theory into a practical form. We completed our designs the following week, and they have lain by ever since. Not being able to follow up our theory, we submit copies of them to your inspection, and, if worthy of publication, hope to see them published for the public benefit.—Yours, &c.,

CHARLES STEPHEN CANNELL.

Thorpe St. Andrew, Norwich, Norfolk.

F M F M are field magnets (four in number, two in front and two behind), elongated at each end so as to go right through A A A A and B B the bearings (brass), with a nut at the end to hold all together (Fig. 1).

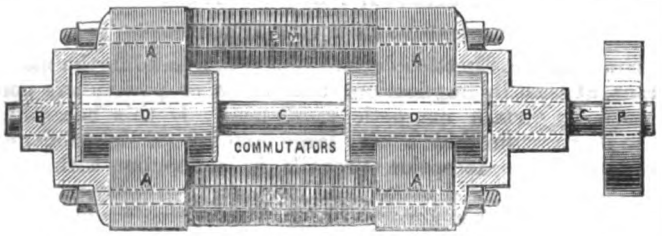

FIG. 1.—Cannell's Dynamo Machine.

A A A A are solid pieces of wrought iron, of the thickness of the length of armature magnets, and of the following shape (Fig. 2). 1 1 are holes for ends of field magnets.

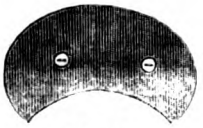

FIG. 2.

B B are the bearings, of brass, cup-shaped, with an angle on one side to fasten dynamo to support.

D D are the armature, on shaft C.

P is the driving pulley, C being the shaft.

The armature consists of four square magnets, which, when bound with wire, form an almost complete circle (Fig. 3).

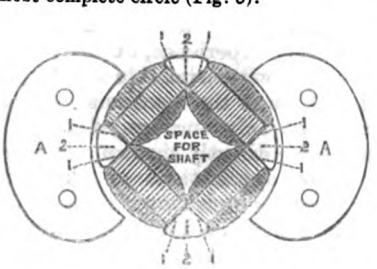

FIG. 3.—Armature.

The magnets are held together by four pieces of wrought iron, a piece projecting from each magnet (1 1 1 1), fitting corresponding holes in corner pieces, and a piece left on at each end of each corner piece (2 2 2 2) to be rivetted to brass plates, to hold all together.

A A (Fig. 3) represent A A in Fig. 1, shown sideways, so as to show the appearance of the end of dynamo.

THE POSTAL TELEGRAPH DEPARTMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With your kind permission I shall briefly examine the communication which appeared under the above heading in your issue of the 17th ult., and signed "Technological."

Passing over the dreadful prognostications of a "T. S. Operator" and "Technological," the alarming attitudes of clamorous associates of chambers of commerce, and the petitioning public, I would point out that so far back as 1872 it was distinctly stated (*Organisation of Staff*, Form H—21) that "No clerk will be promoted from one grade to another who is not able to pass an examination in the methods of connecting up instruments in various ways in circuit." This, I understand, is what is now known as technical knowledge, and, that being so, it is a knowledge which the Department has a right to demand from every operator; and, moreover, it is what is looked for from every operator who is something more than automatous. There is no denying that the possession of such knowledge by the officers of the Indian telegraph service has been of advantage to that service, and that the possession of a like accomplishment by the officers of the Postal Telegraph Department would be, as the heads of that department rightly consider, advantageous. Finding that a large majority of the operators take no interest in their work, and are, therefore, untrustworthy, the authorities do the next best thing—they provide an engineering staff to look after the mechanical and more serious defects, and testing officers to adjust the high speed Wheatstone duplex and quadruplex apparatus, and to report to the engineering staff when a wire or piece of apparatus is faulty, so that the defects may be made good. How little, then, is left to the automatous operators!

We are told that many instances have recently occurred where the postal superiors have pronounced against "technical science." This assertion is worthless without proof, and if some one did make such remark it must have been in a fit of disgust at the never-ceasing cry, "Technical knowledge is mine; I am superior to all around."

I would here ask the question, Do the telegraph superiors always encourage the pursuit of technology, and do those who themselves possess such knowledge show any disposition to impart it to their fellows? The answer, I fear, must be negative.

But, after all, what does the contention of "Technological" amount to? To nothing more than this—that every operator cannot regulate his or her instrument and discover whether a fault is between A and B or A and C. I can do these things, no matter how; *ergo* I should be placed upon a pedestal, adored, and propitiated by all; and this notwithstanding the fact that in other respects I am infinitely inferior and incapable of discharging the higher duties of supervision.

The statement made by Mr. Fawcett in the House of Commons, and referrred to by your correspondent, I believe to be correct; and it must be extremely gratifying to the right hon. gentleman to learn that the telegraph clerks "are turning their energies to other and more appreciative channels" for there is some hope of their views being thereby widened, and the absurdity of the comparisons they are continually making with Postal officials avoided. These comparisons are only so many proofs of the consciousness of the telegraph operators that their duties are inferior to those of the sorters. They are painfully aware that, while their duties are automatical, those of their *confrères* continually call for the exercise of intelligence, and in addition to which they hold a position of trust and responsibility.

"Technological" out Herods Herod in his comparisons, for not only does he find fault with the allotment of appointments to the postal officials, but clearly states that it would have been equally offensive to him if post-transfer clerks had received them. Even although they might be the possessors of the much-vaunted technical knowledge I venture to say that if another comparison were made it would be found that in respect of technical knowledge the post-transfer clerk will compare not unfavourably with the pre-

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transfer. Here we have "Technological's" case in a nutshell, and the panacea for all the troubles of the Post Office authorities, the soother of fretful associates of the chambers of commerce, and the satisfier of the petitioning public. It is—give to the *employés* of the late companies the lion's share of the superior appointments, irrespective of their right to same, or possession of the abilities which are requisite for the proper discharge of the duties of an elevated position.—Yours, &c., NOT A TELEGRAPH CLERK.

THE RECENT AURORA CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 22nd inst. you notice the extraordinary display of the aurora in America, and the general interruption to telegraphic traffic.

As the electrical disturbance due to this aurora has been the most widely spread and violent since February 5, 1872, some further information may be of interest to your readers. I have, therefore, collected what data I can from the stations of the Eastern and Eastern Extension Telegraph Companies.

This data is necessarily imperfect, as, of course, the traffic is of the first importance, and particularly when there is any difficulty in working, the whole efforts of the staff are devoted to preventing delay.

But the facts which I enclose will show to what extent the disturbance extended, and in some cases the force of the currents; I may also mention that owing to our system of working all the longer lines with condensers at both ends the effect of these currents is not noticed except when they become very strong.

Observations taken at Madras and Penang show that the current at those stations was at times equal to 200 Daniell cells. The land lines in England, on the Continent, in India, Australia, and New Zealand, were also affected, in many cases entirely stopping traffic.

Mr. Fuller, of the Direct United States cable, and Mr. Carson, of the Anglo-American cables, have kindly given me some information. The disturbance on these cables began on the night of the 16th and increased in violence during the 17th. This disturbance continued with such force for several days that the traffic was very much delayed; at the earlier part of the period indeed it was stopped altogether: at other times duplex working was rendered impossible.

The disturbance has gradually diminished, and now the cables are resuming their normal condition, there being no disturbance at this end of the cables; but there is still slight evidence of it on the American side of the Direct United States cable.

I think this fact is very interesting as a proof that the disturbance began on the American side, and that the normal equilibrium is being gradually restored towards America.—Yours, &c., H. SAUNDERS,

Electrician-in-Chief, Eastern Telegraph Company.

AURORA CURRENTS OBSERVED, MONDAY, APRIL 17, 1882.

Time, 5 a.m. Section, Porthcurnow-London. Reported from London. Strong; on all lines work stopped.

Time, 5:45 a.m. Section, Porthcurnow-London. Reported from London. Strong; working badly on all circuits. Exeter reports all lines same state.

Time, 7:25—8:17 a.m. Section, Porthcurnow-London. Reported from Porthcurnow. Variable; working with difficulty.

Time, noon. Section, Porthcurnow-London. Reported from Porthcurnow. Tried duplex, but line current too variable to maintain balance.

Time, 12:16 p.m. Section, Porthcurnow-London. Reported from London. Variable; working with difficulty. Exeter reports strong on all lines.

Time, 1:32—37 p.m. Section, Porthcurnow-London. Reported from London. Strong.

Time, 1:34—39 p.m. Section, Porthcurnow-London. Reported from Porthcurnow. Strong; current held relay over and stopped work.

Time, 1:41—2:25 p.m. Section, Porthcurnow-London. Reported from London. Strong; current varying, stopped traffic. Post office said stopped on nearly all wires.

Time, 2:3 p.m. Section, Porthcurnow-London. Reported from Porthcurnow. Can't read Exeter or London.

Time, 2:28—2:32. Reported from London. Very strong.

Time, 2 p.m.—2:9 Section, Lisbon-Porthcurnow. Reported from Porthcurnow. Varied from 17 volts pos. to 19·5 volts neg.

Time, 7:50 a.m. Section, Marseilles-London. Reported from London. Stopped to Marseilles. Paris says all lines affected by aurora.

Time, 8:10 a.m.—4:0 p.m Section, Marseilles-London. Reported from London. Very variable, and at times traffic entirely stopped.

Time, 8:52 a.m.—2:0 p.m. Sections, Gibraltar-Lisbon, Villa Real-Gibraltar. Reported from Gibraltar. Strong; not noticeable on Malta circuit.

Time, 3 p.m. (G. t.). Sections, Gibraltar-Malta, Bona-Malta. Reported from Malta. = 11·4 cells neg.; working Bona, Morse interrupted throughout day.

Time, 6 a.m.—9 p.m. Section, Corfu-Trieste. Reported from Corfu. Strong.

Time, 7 a.m.—6 p.m. Section, Corfu-Trieste. Reported from Trieste. Strong; especially between 7 and 9 a.m. and 5 and 6 p.m.

10 a.m.—12 p.m. Sections, Otranto-Zante, Canea-Zante. Reported from Zante. Strong; variable.

Section, Chio-Dardanelles. Reported from Chio. Strong; variable, particularly between 4 and 6 p.m.

Time, 9 a.m. to midnight. Section, Pera-Dardanelles. Reported from Pera. Working interrupted, current = 14 cells.

Time, 9 a.m. to midnight. Section, Pera-Odessa. Reported from Pera. Working interrupted, current = 25 cells.

Section, Pera-Odessa. Reported from Odessa. Working interrupted, current = 30 cells.

Cyprus reports currents 20 per cent. greater than usual on all circuits.

Time, 7:30 a.m.—3 p.m. Section, Madras-Penang. Reported from Madras. Strong, variable; at noon increased from 23 to upwards of 200 cells in one minute. Recorder suspension broken twice.

Time, 9 a.m., 3 p.m. Section, Singapore-Penang. Reported from Penang. Very strong and variable, sometimes equal to 200 Menottis, giving a spark at terminal when contact broken.

Section, Singapore-Saigon. Reported from Saigon. Greatly affected working, especially at 6:30 a.m. to 5:30 p.m., and 10:30 p.m. to midnight.

Section, Hong Kong-Saigon. Reported from Saigon. Greatly affected working, especially at 6:30 a.m. to 5:30 p.m., and 10:30 p.m. to midnight.

Section, Hong Kong-Saigon. Reported from Hong Kong. Strong current delaying traffic.

Section, Hong Kong, Manila. Reported from Hong Kong. Strong current delaying traffic.

Section, Sydney-New Zealand. Reported from Sydney. Working stopped on land lines, both Sydney and New Zealand. On cable equal to 10 cells.

AURORA CURRENTS OBSERVED, THURSDAY, APRIL 20, 1882.

Time, 7—7:50 a.m. Section, Marseilles-London. Reported from London. Strong; lost Marseilles. Paris says, "unable work 50 wires."

Time, 6:56 p.m. Section, Marseilles-London. Reported from London. Strong.

Time, 7:20—7:40 a.m. Section, Porthcurnow-London. Reported from London. Strong.

Time, 9:30 a.m. Section, Porthcurnow-London. Reported from London. Varying.

Time, 5—8 a.m. Sections, Gibraltar-Lisbon, Gibraltar-Villa Real. Reported from Gibraltar. Slight disturbance.

Section, Gibraltar-Malta. Reported from Malta. Equal to 5 cells neg.

Section, Bona-Malta. Reported from Malta. Equal to 8 cells neg.

Time, 12 a.m.—1 p.m. Section, Trieste-Corfu. Reported from Corfu. Strong.

Time, 12·15 p.m. Section, Aden-Zanzibar. Reported from Aden. Variable.

Time, 1:47 p.m. Section, Suez-Aden. Reported from Aden. Equal to 30·5 cells pos.

Time, 2 p.m. Section, Bombay-Aden. Reported from Bombay. Strong. Greatest results equal to 33·9 cells pos. to 28·84 neg.

Time, 9:30 a.m.—11:30 p.m. Section, Madras-Penang. Reported from Penang. Strong and variable.

Time, 9 a.m.—3 p m. Section, Singapore-Penang. Reported from Penang. Strong and variable.

Time, 6 a.m.—1 noon. Section, Batavia-Singapore. Reported from Batavia. Strong.

Time, 9 a.m.—5 p.m. Section, Rangoon-Signapore. Reported from Rangoon. Strong.

Time, 10 a.m.—2 p.m. Section, Singapore-Saigon. Reported from Singapore. Traffic delayed.

Section, Singapore-Saigon. Reported from Saigon. Delayed traffic throughout day.

Section, Hong Kong-Saigon. Reported from Saigon. Delayed traffic throughout day.

Section, Port Darwin-Batavia. Reported from Batavia. Very strong all morning.

Time, 9 a.m.—4 p.m. Section, Port Darwin-Batavia. Reported from Port Darwin. Very strong.

CHEMICAL REPULSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: *A propos* of Mr. Sprague's paper against the popular idea of "Repulsion," which contains some good thoughts well and forcibly expressed—albeit I may not agree with him in all minutiæ—I find a good illustration in *Nature*, under their "Abstracts of Foreign Chemical Proceedings." The abstract in question may not be intelligible to some who do not believe in molecules and other scholastic abstractions; it is, therefore, at some risk that I venture to give a free translation of what may be the substance of the paper. "Her Lecher" has been studying the "chemical repulsion" of E. Mills, where a few drops of "barium chloride" solution are placed on the surface of a glass plate, on which another glass plate is pressed, having two round holes perforated therein. A drop of sulphuric acid is placed in each hole,

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which forms "barium sulphate" in expanding circles, which, however, do not meet, and hence E. Mills's theory of chemical repulsion acting at a distance. On the contrary, from many experiments, H. L., assuming the chloride atoms to be equally diffused, thinks that, in proportion as they are *fixed* in the insoluble sulphate, other atoms tend to diffuse inwardly, so that before the circles meet there are no longer any chloride atoms, and therefore the action stops.—Yours, &c, SAM. E. PHILLIPS.

THERMO-ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If your correspondent "E. E. A." will substitute a telephone for his astatic galvanometer, he will obtain audible evidence of a current; as also if he employ water instead of the gas flame. I asked for an explanation some two years ago, and was told the supposed "equal density" of the two conducting wires was illusory, and that in fact the current was due to *dissimilarity*. "E. E. A." is at liberty to reject or accept this explanation just as I was. I have not accepted it yet.

When using the telephone, it is necessary to make and break metallic contact in the flame; and in water to make and break with the surface of the liquid, in order to get a sound.—Yours, &c., J. L.

April 24th, 1882.

TRANSMISSION OF MUSIC BY TELEPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The members of our Exchange in Edinburgh are much interested at present in listening to music per telephone while sitting in their offices or dwelling houses.

An instrument has been fitted up in the Waverley Market, where the International Fisheries Exhibition is attracting thousands of visitors. Military bands are in constant attendance, and it is truly wonderful with what accuracy every note is transmitted. More especially is this so when the band stand is situated some seventy-five yards from the call box.—Yours, &c., GEORGE E. WATSON, District Secretary.

National Telephone Co., Limited, Edinburgh,
April 25, 1882.

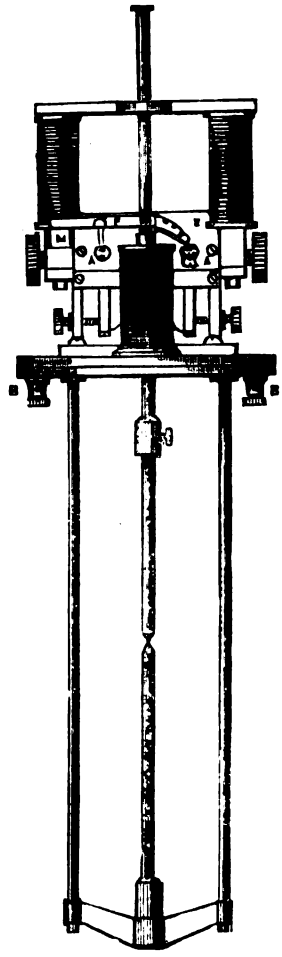
JUSTICE.—We have received your letter, but you do not give your name. It is necessary that correspondents should give us their name and address—not for publication, but in good faith. We will bring your letter before the authorities you mention and see that the case is duly considered. If an alteration is made there will be no need to pulish your letter, as the matter is more of a kind for the consideration of the managing director than the public.—ED. *E.*

INSULITE.

This is the name of a new insulating material which has been patented by Dr. Fleming. We understand that a company has been formed to work this insulating material on a large scale, and that all the capital has been subscribed. So far this shows great confidence in the material, and in the ability and knowledge of the patentee. The material has been, we are informed, severely tested by many of our most eminent electricians, and their reports are very favourable. Among others who have tested "Insulite," we may name Sir W. Thomson, F.R.S., J. Fletcher Moulton, F.R.S., and W. H. Preece, F.R.S. The verdict of such authorities is almost conclusive as to the merits of any insulating material. Hitherto we have used glass, porcelain, stoneware, gutta percha, india rubber, and ebonite. The great demand likely to be made upon the last three insulators, it is thought, will tend to raise the already fairly high price, and thus investigators have been led to try and find some other good and cheap material. Insulation, and good insulation, seems to be an absolute necessity, not only in the finer phases of telegraphic and telephonic work, but in the great undeveloped field of the electric light. It is thought that Insulite is the very material for the purpose. Dr. Fleming has discovered a method by which wood, sawdust, cotton waste, paper pulp, and other fibrous materials, can be converted into a material impervious to moisture and acids, easily moulded under pressure into any form, and capable of being worked or cut into any shape. This material is an excellent non-conductor of electricity, and can be used for all forms of battery cells, telegraph insulators, supports for electric light leads, &c. Its cost is said to be moderate, and to compare favourably with that of gutta percha and ebonite, and it is probable that it will replace the latter for use in all kinds of electrical instruments, inasmuch as it is cheaper and does not deteriorate in quality. We shall shortly hope to give various figures, the results of tests of this new material.

LEVER'S ARC LAMP.

The accompanying diagram illustrates Mr. Charles Lever's invention for regulating arc lamps. An electro-magnet, included in the main circuit, acts upon oscillating armatures to which bearing springs are affixed, so as to give an upward motion to the carbon-holder when required. When no current is passing the upper carbon rests upon the lower. On the other hand, when the current is passing and the resistance of the circuit increases with the consumption of the



carbons the grip of the electro-magnet armatures is reduced and the upper carbon falls to the required distance. The arrangements, which are ingenious and novel, appear to be well adapted for automatically maintaining a uniform light, and for shunting the current in the case of accident.

Our diagram represents a back view of the lamp.

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CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

The adjourned general meeting of this Company was held on the 24th instant, at the City Terminus Hetel, Cannon-street, Sir Julius Vogel presiding.

The SECRETARY (Mr. Charles Curtoys) having read the minutes of the statutory meeting, which were confirmed by the present meeting, and signed by the chairman, the report of the directors was taken as read. It has already appeared in the *The Electrician*.

The CHAIRMAN: Gentiemen—It is now my pleasure to propose that the report and accounts now submitted to the meeting be received and adopted. It is a very pleasant duty for me to congratulate you upon what I may term the success of the Company hitherto. We commenced under some difficulties. It was not thought desirable when we first commenced that we should establish a factory on a very large scale. There was certain litigation pending in which we were not directly concerned; but still it was thought that the more modest we were to begin with the better for telephone interests in general. But our modest beginnings were soon found quite insufficient for our requirements, and now we have a large factory, fitted up with the electric light, capable, I think, and hope, of meeting the demands upon it. Hitherto, I may say, that our difficulty has been—a difficulty which the shareholders will be most pleased to learn—to supply sufficient telephones to meet the demands upon us. We have always found it difficult to meet the large demands on us from our customers and to meet our contracts on hand. As to the accounts, I think they sufficiently explain themselves and it is not necessary for me to go through them in detail. The net profit is £23,087. Out of this it is proposed that some portion of the preliminary expenses should be written off, and that there should be a reserve put apart to meet deficiencies that may arise at any time with respect to outstanding accounts. Our outstanding accounts being large, and always likely to be large, it was thought desirable to make this reserve. £5,000 has already been paid as interim dividend, and we propose now to ask your sanction to a further payment of £5,000 for the end of March, and to carry forward an amount of £5,600. I may explain that when first the question came before the directors of a division of profit, it was thought that it would be agreeable to the shareholders (this being a manufacturing company and not a speculating one) that there should be regular quarterly dividends paid, which the shareholders might feel they had a right to rely on; and after making our calculations we found that we might fix on a rate of 10 per cent., and that we could pay that amount regularly in quarterly dividends, leaving to future disposition the question of dividing special bonuses. We commenced that course in December, which really represented about three months of effective working. The £5,000 we propose to divide for the end of March will be at the rate of 10 per cent. for the March quarter. If this course meets your pleasure the proposal of the directors will be to pay regularly dividends at the end of June, September, and December of sixpence a share, which is 10 per cent. The final dividend must always be declared at the annual general meeting. We think it would be well to leave for a time the question of dealing with profits in excess of that amount; and that is why, although the profits show a much larger amount, we do not ask you to divide more than this rate of 10 per cent. for the quarter now. Dealing with a company like ours, it is desirable that there should be something in the shape of reserve, and we think the interest we have acquired in the River Plate Telephone Company and in the Edison Gower-Bell Company, set aside, make something more than an ample reserve in respect of depreciation of patents or anything else. As to these two companies, the Edison Gower-Bell Company was the outcome of a large amount of litigation which ended in a fusion of the Edison interests and his associates on the Continent with the interests we represent under our purchase from Mr. Gower. Primarily, these interests were not taken into account when we made this purchase. The Edison Gower-Bell Company is now at work. It has established exchanges in Portugal, and is in negotiation for selling its patents in Russia, and is also in negotiation with respect to other parts of the Continent. I would not be prepared to say that our interest in that company is worth the nominal value of the shares we hold—£175,000, but I think I may say that it is a substantial and valuable asset. Our shares in the River Plate Company, I think, are fully equal to their nominal amount, £20,000, so that, gentlemen, you have as a result of the year's working, besides the 10 per cent. dividend we have paid, a substantial amount put apart for special reserve to meet any possible accounts which may not be found good, not only in the present but for future times. At present we have no reason to think that any of these accounts are not good. We propose to carry forward an amount equal to the quarterly dividend we propose to pay, and I hope that you will think that that is a satisfactory conclusion of our year's business. You have, in addition, kept apart separately the value of the River Plate Telephone shares and of the Edison Gower-Bell Telephone Company. These we are not proposing to divide, and have retained as substantial asset for a reserve to our benefit. So much in respect of the past, which I again say I hope you will think is satisfactory. As regards the future we have contract engagements a very long way ahead. All our customers, our clients, whether Government or private, are continually at us, like Oliver Twist with the cry of "more and more." In fact, as I have said, our difficulty has been to keep up to the demand. That tends to prove the fact that the telephone is making a very large amount of progress. I do not know if I am wearying you with my remarks, but if not, I should like to say something more as regards our future position. I think it is as much the duty of directors to prevent shareholders from undervaluing their property as it is to induce them to abstain from overvaluing it. To give you a clear idea of our position, I must travel somewhat out of the immediate purpose of the meeting, and refer both to the United Telephone Company and to the General Post Office. Our arrangements with the United Telephone Company are that that company, for a long series of years, is bound to buy all its instruments of us, and that remark applies not only to the United Company but to the companies affiliated to it. We are also the sole persons who are licensed to manufacture in this country telephones for export to foreign countries. As regards the Post Office, our position is this—that we have contracts with the Post Office for a very considerable number of instruments, and a further conditional contract for the supply of a very large additional number; and, in considering our position, I think it is necessary to refer to the position of the United Telephone Company. As most of you aware, when the United Telephone Company became possessed of the monopoly of the telephone as it were, the Post Office intervened, and claimed to have the right of using the telephone, it being an infringement on the Government rights secured to it by statute—by the Telegraph Act. Well, that course at the time was considered a very unusual one, and many thought it was conceived in a narrow spirit. I think, if we come to look at the circumstances, we cannot agree as to that conclusion. The fact is, the Post Office was bound to protect the very large interests which the nation had in the telegraph property acquired by the Government, and the Post Office saw at the very earliest outset that the telephone was not only an infringement on the telegraph, but that in course of time it was likely, more or less, to supersede it. Whatever party we may belong to, whether Conservative or Liberal or Radical, I do not think any of us will deny the very great ability shown by the present head of the Post Office—the right hon. Mr. Fawcett. In fact, I should question if in the memory of the present generation there has been so able and efficient a Postmaster-General. The Post Office takes the greatest and the keenest amount of interest in the progress of the telephone, and, although I have no right to say so through any direct communication with the Post Office, I may say that it is obvious to me that they have realised the fact that the telephone is become not only a rival of the telegraph, but is likely to supersede it or to be amalgamated with it. What does the telegraph give you? A very rapid postal system. Instead of sending a letter from Scotland, and it taking, say, twelve hours, a telegraph message is sent in one hour. But if you take Westminster, a telegram to the city would cost a shilling; but a boy might deliver a message more quickly. It is not, however, safe to expect to get a telegram which is despatched in less than three-quarters of an hour. You have thus in the telegraph a very rapid postal delivery, but you cannot compare the interchange of messages by the telegraph with the interchange of thought by conversation through the telephone, and there is no question of this, also, that the telephone is susceptible of being used for long distances. At present that is not done, but that is entirely owing to the fact that if it were allowed to be used for long distances in this country it would clash very much with the operations of the Post Office, but that it can be so used there is no doubt. The system, for instance, belonging to the Oriental Company in Alexandria, and also in Cairo, enables people to carry on a conversation with the greatest facility between those two cities, which are distant 130 miles apart, and there is reason to think that in much larger distances the telephone can be used. I do not think from what I have said that you will have much difficulty in arriving at the conclusion that there must sooner or later be a fusion of the two interests, the telegraph and the telephone. It is not for me to prophesy, but that that is likely to be the case I think there is very little doubt, and I am also of opinion that the telephone interest will not buy up the telegraph interest, and therefore if there is to be a fusion it will not be in that way. There has been a great deal of litigation. Necessarily there would be in dealing with such a valuable discovery as the telephone; and I believe an action is being commenced this very day upon the subject. For my part I think it matters very little how it issues. The Post Office has shown itself very chary of granting fresh licenses. It is, however, obvious that the larger the number of licenses, the more it extends permission to use the telephone throughout the country, the greater will be its difficulty when it has to come to an account with all the various interests which will thus arise. As far as we are concerned, I think I may say that it matters little to us whether the monopoly is in the hands of the Post Office or the United Telephone Company, because our arrangements are such that for more years than most of us in this room are likely to live the United Company, or its assignees (and that applies equally to the affiliated companies), are bound to take all their telephones from us. As regards the Post Office, we have this satisfactory feature to remember, that, apart from our present interests, we have those which we inherit in case they acquire the telephone. We are also working with the utmost harmony with the Post Office to improve the character of the telephone. Scarcely a week elapses without the Post Office sending us some suggestion for improving the instrument, and now the instrument is superlatively better than the original instrument, which, in my opinion, will shortly become almost obsolete. We are ourselves also, with the Post Office, bringing out an instrument which will be better than anything that has yet been brought forward. It is the policy of the board not to trust to anything of a monopoly, but to qualify ourselves by the excellence of the instruments we possess to hold a position without which we should be assailed. We should be condemned if we did not produce the most satisfactory instrument. In short, it comes to this, that the progress of the telephone means the progress of this Company in which you are shareholders, and I have much too high an opinion of the activity—commercially and socially—of the people of this country to believe that they will allow themselves to be denied the largest possible amount of advantage from what I do not hesitate to term the greatest discovery of this age—the telephone. I am obliged to you for the patience with which you have listened to me, and I hope that I have not been too discursive or trespassed on you at too great a length. I have now to move "That the report and accounts as now submitted to the meeting be approved."

Mr. CHALLONER SMITH said he noticed that there was £170,000 in the accounts as shares in the Edison Gower-Bell Company, and £20,000 in shares for the River Plate Company. He did not quite understand the point. They had on the one side these shares, and on the other side they had exactly the same figures both balancing each other.

The CHAIRMAN: Those are the two amounts I referred to as being held in suspense.

Mr. C. SMITH presumed that if the two companies mentioned were successful, and the shares were ultimately sold at par, the Consolidated Company would come in for the amounts.

The CHAIRMAN: Just so.

Mr. C. SMITH: In the meantime the items were put in the balance-sheet until realised?

The CHAIRMAN: Yes, that is so.

Mr. J. B. BIGELOW seconded the motion.

The CHAIRMAN: I shall be very happy to answer any inquiries.

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Mr. W. FORD understood, with regard to the question of the hon. proprietor who last addressed them, whose question was very relevant, that the shares of the two companies mentioned figured in the balance-sheet as they did till the shares were productive, when he presumed they would become distributable assets as profits.

The CHAIRHAN: Most unquestionably they will be at the disposal of the shareholders.

Mr. FORD: Yes, at the disposal of the shareholders as profits. It would never have done for the directors to allow these shares to remain as distributable assets of the Company, which they would have been if they had not placed them to suspense as they had done.

The CHAIRMAN: That is so. They are premium shares received by the Company. They would be divisible if you thought it advisable to do so.

Mr. FORD observed that other companies had followed the exceedingly bad plan of distributing dividends on such items.

The CHAIRMAN: We might estimate them at par, and say we give 75 per cent.

Mr. E. H. GALSWORTHY remarked that the shareholders did not seem disposed to make any comments on the balance-sheet. He, however, thought that the accounts of the Company were too good to be passed over in silence. He took it that, in the absence of the directors knowing what the exact value of the shares referred to was, they had put them in suspense till they could deal with them at some future time, and that when that time came possibly they might sell them, or consult the shareholders. Whatever assets they realised would be distributable among the shareholders as bonus, and not by way of dividend. It would be a matter for the directors to consider, no doubt, before they did that, what extent of reserve fund they should form. The business of the Company was, of course, peculiar. They had a capital expenditure of £138,000 for goodwill, patent rights, &c., and probably the directors hereafter would think it well to form such reserves as would restore the capital to the shareholders. When that was done any balance which they might have would be distributable absolutely as bonus. He was one who was very contented, in the meantime, with 10 per cent., which he thought was rather a charming prospect. He congratulated the board on the course they had taken in not being tempted, even in the face of the figures before them, to go beyond 10 per cent. He thought that one of the first duties of all directors was to have their companies in a sound condition, and certainly there was no better means towards that end, than commencing, even in that early age of their existence, the formation of a reserve fund. He thought, therefore, as the chairman had hinted, that he would be glad to have an expression of opinion from the shareholders, that they should say (those who thought so) that the directors had done well in forming a reserve fund. The shareholders must, he thought, be satisfied with the position pointed out by the chairman in support of the view that, while shareholders should not over-rate the value of their property, they should not underrate it. It must be satisfactory to the shareholders to hear that the directors are working in harmony with the Post Office. It was difficult to see where the telephone would end. One of the great objects should be to supplement the telegraph. With regard to the accounts, he was not quite clear that the shareholders had been furnished with all the information which they should receive according to the Articles of Association of the company. An account of income and expenditure should be given, whereas the accounts, as presented, were rather in the form of a balance-sheet. He should not press for the information to be given to them—he only called attention to it; but, perhaps, the directors would consider the matter, and have the Articles of Association, in accordance with the conclusion at which they might arrive. He tendered his hearty congratulations to the board, and thought that the shareholders must really feel indebted to them for the admirable way in which the affairs of the Company had been so far managed.

Mr. C. SMITH wished to supplement what had been said by the previous speaker by another remark. They had good-will, patent rights, &c. He assumed that the directors had not thought fit to write anything off that at present, and the shares that they held in suspense would be quite enough for any depreciation in that item. Therefore, he apprehended that if £10,000 or £15,000 had to be written off the good-will, and so on, they would be perfectly right in taking that amount off the sum realised by these shares. He did not think that they ought to look too much to that asset at present, for he should like to have seen a certain amount written off the goodwill, &c. He was very satisfied that that object was achieved by having the shares in the other companies which had been mentioned in in suspense. He presumed that the next quarterly dividend, which was up to March 31, was overdue, and, therefore, it would be paid at once.

The CHAIRMAN: It will be as I explained. We shall pay quarterly dividends for June, September, and December. Those are interim dividends, but the final dividend for the quarter ending March will be declared at the general annual meeting. It is not in accordance with our Articles of Association, or with the articles of any company to pay final dividends without the approval of the shareholders. Three quarterly dividends will therefore be paid regularly, and the last quarterly dividend will be declared at the annual general meeting.

Mr. C. SMITH thought that the last quarter for March was overdue now, but it was to be put off till the end of June.

The CHAIRMAN: No; it is due now, and the moment you authorise its payment, we shall send out the warrants. I would like to say a few more words as to those shares. When we purchased these interests of Mr. Gower, we purchased out all his interests, and in various parts of the world interests more or less definite have grown up, and it became our duty to make the most of them. I could not tell you the laborious task it has been to thrash out these various interests, and to make the most of them. Any one who has been carrying on negotiations for patent rights and so on where separate interests are concerned may have some idea of these difficulties. We have so far brought to light and put in a substantial shape our interests in Europe in conjunction with the Edison interests, and we have put in a separate shape our interests in the River Plate Company. The River Plate is a going company, and the accounts we receive from our agent there are so exceedingly satifactory that we have no hesitation in saying that we think those shares are worth their par value. The European matter is a matter that must be worked out carefully, and will take some time. I do not say for a moment that the value of those shares is as large as the amount they represent. At present we make no valuation of them.

Mr. GALSWORTHY inquired if the Company had parted with all their interests abroad.

The CHAIRMAN: Well, I think we have some interest in South America still, and there are certain interests which may grow up in foreign countries where we have the right to use our instruments which may be made the subject of negotiation with other companies who have similar rights, and which may be calculated in future. I am not in a position to give you any more definite answer now, and I am obliged to you for your suggestions.

Mr. C. SMITH suggested that not more than 10 per cent. dividend should be paid until the preliminary expenses of the Company, which related to themselves, were paid off. With regard to the two other companies mentioned, some expense, no doubt, had been incurred in getting the shares which this Company held, and he would suggest that those expenses be placed against those companies. So far, however, as the expenses of the Consolidated Company were concerned, he held that they should be paid off before a higher rate of dividend than 10 per cent. was declared.

Mr. FORD thought that this was a matter which should be left with the board.

Mr. C. SMITH stated that he had only made the suggestion as that was the first meeting of the Company.

The CHAIRMAN: I entirely understand the question and the suggestion, and I think it is met by the fact that we only propose to pay 10 per cent. without the sanction of a general meeting, and until we come before you again. I don't think it is right to ask you to mortgage your future opinion. If we do not then propose to write off these expenses it will be for you to object, but the policy you speak of, of writing off the preliminary expenses before we give any higher rate of dividend, is what we contemplate. I will now put the resolution, "That the report and accounts be adopted." The resolution was carried unanimously. Continuing he said: I have now the pleasant duty to propose, "That a final dividend of 6d. a share, free of income tax, for the quarter ended March, 1882, be declared and paid." You will notice that that means 10 per cent. on the quarter, and that is the rate that we intend to continue.

Sir A. ARMSTRONG, K.C.B., seconded the motion, and it was carried unanimously.

Mr. C. SMITH moved the re-election of the auditors, Messrs. Deloitte Dever, Griffiths, and Co.

Mr. FORD seconded the motion, and observed that the doing so gave him the opportunity of directing attention to a suggestion made by one of the shareholders (Mr. Galsworthy) that the accounts did not show a trading account. That was the case, and his seconding the motion gave him the opportunity of calling on Mr. Griffiths to explain the absence of the account. He was glad that attention had been called to this matter.

Mr. GRIFFITHS stated that the reason why the trading account had not been put in the accounts was because it was not deemed expedient either by the directors or the auditors to lay before the public the result of their trading, and because it was quite sufficient to show the balance-sheet.

Mr. FORD observed that he believed he was right in saying that the Telegraph Construction and Maintenance Company always declined to give the trading account for the same reason.

Mr. GALSWORTHY said from what he had heard from Mr. Griffiths he was glad that he had drawn attention to the matter. He had said that he would not express any opinion on it, and now he saw after what Mr. Griffiths had said that it would not be judicious to give it. On some future occasion, however, the Articles of Association should be altered to meet that view of the case, for it was not well that shareholders should rest under the impression that the Articles of Association were not being complied with. They must get rid of that, or they would have a different body of shareholders persisting in the information being given.

Mr. FORD: Not so long as they have 10 per cent.

The CHAIRMAN: I do not think it would be to the interest of the Company that we should designate our business more particularly than is done in the present accounts. He then put the motion for the re-election of the auditors, and it was carried unanimously. Continuing, he moved "That the future general meetings of the shareholders be held in the month of April or May in each year." It had, he said, been already explained why the meetings cannot be held in March, and the Articles of Association provide that they shall be held in March, unless otherwise prescribed. Our financial year ends on the 31st of March. It may be possible—and if so it would always be advisable—to hold the meeting in April, and that is why we say April or May. It would be unwise, too, to bind us to have the general meeting on any particular date at the end of the financial year.

Mr. C. SMITH seconded the motion, which was carried unanimously.

The CHAIRMAN having formally intimated that that closed the business of the meeting,

Mr. C. SMITH moved a vote of thanks to the chairman and directors. Every shareholder present must have been as pleased as he at the vervable and lucid account given to them by the chairman of the position of the Company.

Mr. FORD expressed his pleasure at seconding the motion. At the same time, too, he had to congratulate them, having referred to the 131st of their Articles of Association, that they had rendered the accounts in strict conformity with the article. He felt perfectly satisfied, from having had a very large experience in reference to Articles of Association, that the directors had acted strictly within the powers conferred on them, and that if they had included a statement of the trading of the Company it would have been in excess of the requirements of the statute.

Mr. GALSWORTHY observed that it was not worth while to pursue the subject, but he might say, having also had considerable experience of Articles of Association, that he was clearly of opinion that the accounts submitted to them on the occasion were not in pursuance of the Company's articles [laughter].

The CHAIRMAN: Before you leave the room allow me to say that we are very much obliged to you for this vote and for your attendance to-day. As a rule shareholders in successful companies take very little interest in their affairs. Generally the meeting rooms are very crowded when the companies are not successful. In this matter, however, apart from any commercial interest that may attach to to-day's meeting, it must be interesting to belong to a company connected with so interesting a subject as the telephone. Nothing could be more satisfactorily to the directors than having met you under the circumstances of to-day, and in having received from you so cordial a recognition of our services.

The meeting then separated.

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THE GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

The eleventh ordinary general meeting of the shareholders in this company was held on the 26th inst., at the offices, Old Broad-street, under the presidency of Sir James Anderson.

The SECRETARY (Mr. William Payton) read the notice convening the meeting, and the minutes of the last ordinary and extraordinary general meetings, which were confirmed by the present meeting, and signed by the chairman as correct. The report of the directors was taken as read. It has appeared in *The Electrician*.

The CHAIRMAN: As we have taken the report as read, I will call your attention to a few points. First, we have laid the new cable, and it was opened for traffic four days ago. We cannot yet say anything about how far it will prove successful or otherwise. However, there is no doubt about this—that a cable direct from Germany had to be made by someone, and that we are fortunate in having secured that concession with its advantages. The cable is now working well. The German report calls our attention to this point—that the capital originally thought necessary for that cable was £165,000, but by competition and some good management on the part of the German Board they have got it for £20,000 less than the amount, therefore that £20,000 capital in excess of the amount required has been subscribed, and has been invested by the Berlin Company in Four per Cent. Government Stock. At the extraordinary meeting you will remember that the shareholders were promised that they should have an opportunity of subscribing for the new capital, and I think without exception the shareholders got all they applied for, the *pro rata* amount, and we tried for some time to find a plan—an inexpensive plan—of getting our shares quoted on the Stock Exchange, but that appeared to be difficult and expensive, and the German laws seem to prevent them paying any money towards getting those shares quoted. But we have found a means of doing without the quotation. The cable, as I have said, is laid and working well, but we must wait for a year to see what comes of it. During the winter our main cable unfortunately broke, and had we had the new cable to Valentia we should have saved a considerable amount. But we lost only the American traffic, securing our European traffic by the arrangements we have with the Post Office and the Submarine Company, so that, after all, our revenue did not cease altogether. As to the repair of the cable, we had an opportunity day by day of knowing how the grappling was going on, and the operation was very disheartening. Once or twice the cable was got, but at one time we thought you were likely to lose thirty or forty miles of the cable, which was buried in sand, and new cable was made with that result in view. However, as time went on they found that the cable had been laid north of the supposed position on the chart. No doubt that was owing to thick weather and strong tides when it was originally laid. Ultimately they got nearly all the cable up, and we are fortunate in having to deal with the Telegraph Construction Company, who I am quite sure will not force on us the usage of the cable which has been made, but will find a means of disposing of it. After all, therefore, the broken cable may not prove so disastrous as at one time we thought. The German board, with our consent, however, have determined to lay by an additional 5 per cent. out of the revenue until the reserve is back again to what it was last year—£30,000. The reserve sanctioned by the shareholders for some years back is about £4,000 a year. There will, therefore, be an additional £2,000 off revenue till the expense of the last repair and renewal is recouped, whatever that cost may be. It may, and very likely will, tend to reduce our dividends somewhat for a year or so, but we must put up with that to have our property well secured and efficient, and we must have our reserves well in hand. We have all come to the opinion that cable companies, to be succesfully managed, must have a large reserve and renewal fund, because there is so much going on under the water that we cannot see, and we are unable to effect timely repairs, as is done on railways, and in the case of other enterprises, which are visible to the eye from day to day. I regret to have to refer to the loss of the valuable services of Mr. Weaver. He was associated with this Trust Company from the beginning with myself and Count von Reichenbach and Mr. Erichsen, and we know his value very well. Considerations of health have induced him to persist in retiring, and we had no alternative but to accept his resignation. We have appointed in his place Mr. John Denison Pender, a young gentleman well known to us for his energy and extensive knowledge. From being always with us he knows almost about as much of cables as we do, and I am sure that the shareholders will have no hesitation in confirming the appointment when it is proposed in due course. Meantime I will propose "That the report and accounts for the year ended December 31st, 1881, be hereby received and adopted, and that a dividend be declared, payable this day, of 6s. 9d. per share, free of income-tax, making the previous distribution of 5s. 9d. per share a total dividend for the year of 12s. 6d. per share, or at the rate of 6¼ per cent."

A discussion arose as to the £20,000 saved under the contract price of the cable, in which Mr. Pender, M.P., and Mr. Griffith, barrister-at-law, took part, and thereafter the Chairman put the motion in the usual manner, and it was carried unanimously. Continuing, he moved the re-election of Mr. John Denison Pender.

Mr. H. G. ERICHSEN seconded the motion, and it was carried unanimously.

Mr. J. D. PENDER having returned his acknowledgments,

Dr. DRAGE moved the re-election of Mr. Dover as auditor, at the remuneration of £25 for the current year.

Mr. PENDER, M.P., seconded the motion, which was carried unanimously.

The CHAIRMAN having formally intimated that that closed the business of the meeting,

Mr. GRIFFITH thought they ought not to separate without passing a vote of thanks to the chairman and directors for their conduct of the Company's business during last year. That was not a mere formal vote, for the report spoke for itself, and, he thought, was satisfactory; and when they heard that Mr. Pender, M.P., and Sir James Anderson, as members of the Council of Supervision of the Berlin Company were going to Germany to put everything to rights he thought they might be satisfied that their affairs were properly looked after. The dividend was most satisfactory, and altogether he had much pleasure in moving a vote of thanks to the chairman and directors for their able services in the past year.

Mr. PENDER, M.P., seconded the motion, which was carried unanimously.

The CHAIRMAN: On behalf of myself and colleagues I beg to thank you. We will do the best we can. The last twelve months have proved rather a troublesome time, but I hope we shall now go on more smoothly.

The proceedings then terminated.

REUTER'S TELEGRAM COMPANY (LIMITED).

The eighteenth ordinary general meeting of the shareholders in this Company was held on the 26th inst. at the offices, Old Jewry, under the presidency of Colonel James Holland.

The notice convening the meeting having been read, the report of the directors was taken as read. It stated that the net profits for the year ending the 31st December last, after payment of current charges and deducting rebate on unexpired subscriptions, had amounted to £5,779, including £112 brought forward. The usual interim dividend of 2½ per cent. was paid in October last, and the directors now declared a further dividend of 8s. per share, making a total distribution, free of income-tax, of 7½ per cent. for the year. This would absorb £5,542, and leave a balance of £237 to be carried forward.

The CHAIRMAN: I have but a few remarks to make on the report, which is a very brief one. You will observe that the leading features of this report are a satisfactory increase of their receipts from subscriptions and commission, and a less satisfactory increase to their charges for telegrams and agencies. The increase is about £27,000 in the receipts, while the increase in the charges is something like £6,000. There is a set-off on the other side in the shape of a reduction of about £1,500 in the current expenditure, so that the difference is not so great, although it is much greater than we could have wished. The cause of this increased expenditure is certainly not far to seek to those who have watched the events that have been occuring in the past year. In the first place, there was the Transvaal war and the Transvaal peace. I do not like to make use of political language, but I think I may say that neither was very satisfactory to the country, while they have been very costly to us, for we have to have agents, at considerable cost, to report all the events that occur. Then occurred the assassination of the Czar—another matter of very considerable importance; and then the assassination of the lamented President of the United States, his long illness, and the interminable trial of his assassin Guiteau. All this necessitated a very considerable expenditure on our part, but this is not an expenditure that we can regret, because it is, of all things, the very first of our duties to supply the earliest and most accurate intelligence to the public of all events occurring in any part of the world, and it is not only our duty to endeavour to do this, but it is decidedly to our interest, for if we were for a moment to forfeit that, undoubtedly competition would arise. We think it is by far the most prudent and discreet course to, as it were, stifle competition in the bud by sparing no expense whatever to fulfil our duty in the best manner we possibly can. It will be satisfactory to you all to find that we have carried an increase of £550 in the shape of rent to our reserve fund. That is rent that we should otherwise have to pay for this buildiug, but as it is a freehold, though we have not yet paid for it, we place the rent as a reserve, and that has increased our reserve fund from what it stood at last year—£8,278 to £9,449. We have a freehold, on the other hand, valued at £13,000, and a very good asset it is. The item of sundry creditors is not of much importance to you. They have all practically run off, for they are in a constant state of transition. With regard to sundry debtors, we have some £8,000 or £10,000 distributed among about twenty agencies. We keep down the balances as far as possible, but they are generally, I might almost say always, met very fairly except in some few unfortunate contingencies. In the whole of our assets here recorded, we have nothing that we can call a bad debt. There is an item of about £300 or £400, which may come under the head of doubtful; but still we hope that we shall obtain the whole or the greater portion of that, and that it will not stand against us next year. It is a very small item, at any rate considering the nature and extent of our business. You will have observed, I daresay, that our respected and valued secretary is not occupying his usual seat at my right hand to-day. Mr. Griffiths, who is at all times devoted to his duty, and most anxious to do everything he possibly can to further the interests of the Company, undertook at our request to make a voyage to India in order that he might not only supervise the establishment there, but place himself in communication with the leading authorities with the view of carrying out some arrangements that would be beneficial to us. Having been to India myself, I can say that it is no trifling exertion for a man of any age, travelling as he has to from Calcutta to Simla, a distance of 1,500 miles, in very hot weather. We have received recent accounts from him, and I am very glad to say that his health continues good, and that he is prosecuting his mission successfully. I now move the adoption of the report and balance-sheet as presented to you.

Baron de REUTER seconded the motion, and it was carried unanimously.

On the motion of the CHAIRMAN, seconded by Admiral the Right Hon. Sir JOHN C. D. HAY, Bart., M.P., Mr. James Sydney Stopford was re-elected to his seat at the board; and Messrs. Quilter, Ball, and Co. were subsequently reappointed auditors.

The CHAIRMAN: Gentlemen, I have now to propose a resolution, which I will read:—"That the directors be and are hereby authorised to increase the maximum amount to be applied out of the receipts of the Company for the purpose of the officers' life insurance and superannuation fund from £300 to £400 per annum, such increase to take effect from the date of the institution of the fund." The object of the resolution is that we may be able adequately to ensure the valuable life of our secretary, Mr. Griffiths, and we think it only due to him and right and proper that we should do so. This plan of insuring the lives of the *employés* has worked most admirably, and is being resorted to more and more each year by substantial offices. It brackets in one the interests of employers and employed.

Mr. STOPFORD seconded the motion, and it was carried unanimously.

On the motion of Mr. LOVEDAY, seconded by Mr. OATES, a vote of thanks to the chairman and directors was passed, and the meeting then separated.

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GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN.

Abridged report of the annual general meeting, held at Copenhagen on the 15th April, 1882. H. C. Shaw, Esq., presided. The chairman, C. F. Tietgen, Esq., opened his address by remarking that the past year had undoubtedly been the most significant of those ten years during which the company as now constituted had existed. This not only referred to the extraordinary progress which the telegraph had made in China, but also to the prosperous state of the company's general business. He then reported as follows:—

STATE OF THE CABLES.—As in former years the cables had not been free from interruptions. In the far East these had not occurred as often in the first half of the year as in the latter half, when they had unfortunately been more frequent and of longer duration. The Shanghai-Amoy-Hong-Kong cables had been interrupted for fourteen days, the Shanghai-Nagasaki cable for four days, and the Nagasaki-Wladiwostock cable, to which cable nothing had happened since the beginning of 1878, had been interrupted from the 1st November to the 7th December, and again from the 30th December to the 23rd January this year. In Europe the cables had also on several occasions been broken, as well in the North Sea as in the Baltic, but generally the repairs had been effected very speedily. Some of these breaks, happening at the time of the violent gales last autumn, when the cables of other companies also suffered severely, were, no doubt, attributable to causes beyond human control, but most of the other cases could be traced to carelessness in anchoring and to trawl fishing, and he had therefore much pleasure in adverting to the question of

PROTECTION OF CABLES, a question which it had often been desired to bring to an issue. The time had fortunately arrived for this. At the Fishery Conference held at the Hague last summer, the Danish Representative, acting upon instructions received from his Government, brought the matter before the Congress, and it was unanimously agreed that the different Governments should be recommended to follow it up. Since then, this company had, in conjunction with all the other cable companies, applied to the English Government, who readily promised to take the matter into consideration. The same had been the case with other Governments, amongst others, the French, who had now proposed that a congress should meet for the sole object of considering this important question. The company fully expected that good results would arise from such eventual legislation, but, nevertheless, the directors must continue to keep up the efficient state of their two

REPAIRING STEAMERS, which have done good service during last year. The new steamer, the "Store Nordiske," had left for China with a full cargo of cable, part being for the company's own use, part for the completion of the Russian Saghalin contract. Next, in the month of September, this ship had laid a cable for Chinese account across the Yangtsekiang, near Chinkiang, and she has subsequently been employed in effecting the different repairs which became necessary in the Chinese waters. On the arrival of the "Store Nordiske" in China, the "H. C. Orsted" returned to Europe with a cargo of tea, and finally arrived in Copenhagen in November; shortly afterwards she had been chartered for repairs to be effected near Bilbao, for account of the Direct Spanish Telegraph Company; which work had been very successfully done.

TRAFFIC.—Owing to the interruptions of the cables in the far East, the extra-European traffic had suffered; not so the European traffic, as the interruptions did not affect the regular business owing to the company's many duplications, and on the whole, it would be found that the receipts were about the same as those of the previous year.

THE TELEGRAPH IN CHINA.—The most important event of the year had been the development of telegraphy in China. The construction of the extensive land line between Shanghai and Tientsin, which the company had referred to in last year's report, had been commenced on the 16th June, and completed on the 28th November. The line had been erected by two columns of engineers and workmen, one column working from Tientsin south towards Shanghai, the other, from Shanghai north towards Tientsin, and meeting half-ways. The first telegrams were exchanged on the 29th November, after which, the Chinese Government, in order to accustom the public to the telegraph, carried their messages free of charge for a month. Eight *employés* of the company had been engaged for the Chinese service, in the different stations, of which the most important were Shanghai, Soochow, Chinkiang, and Tientsin. The line consisted of two wires, of which one was reserved exclusively for the through traffic between Shanghai and Tientsin, whereas the other was used for the local traffic of the other stations. This great artery for the telegraphic correspondence in the North of China, had already been extended by the establishment of a line from Chinkiang to Nankin, the old capital of the Chinese Empire. This line would probably be extended along the Yangtsekiang to Hankow, the largest and most important commercial town of Central China. In the South of China, the introduction of telegraphs would also commence by the establishment of a line from the most important southern town, Canton, to the flourishing British Colony, Hong Kong. The company had, on the 25th March, signed a contract for the supply of all the materials required, and for the supervision of the erection of the line, the length of which is about 100 English miles. When the line is completed and ready for the opening of traffic, some of the company's staff will be engaged for the traffic service. If the company had thus succeeded in taking such an active part in the development of the telegraph in China, it had mainly been owing to the confidence in the company shown by the Chinese Government, and notably by Li-Hung-Chang, the Viceroy of Tientsin. This eminent statesman, who has added to his other dignities that of an appointment as Imperial Commissioner of Telegraphs for the whole of the Empire, had, under date of the 8th June, 1881, granted the company a concession giving them a perpetual monopoly for the existing cables in China belonging to the company, and another concession by which the company had obtained a guarantee that no other company or person will be allowed for the next twenty years to land cables in any part of China. During this same period of twenty years the Chinese Government had further undertaken that neither would they themselves, nor would they allow other parties to establish land lines in China which might compete with the company's cables. Finally, the Government had given the company the preference in the competition for any contracts which they might wish to make for the construction of telegraph lines of their own. The chairman said that he could not finish this part of his remarks with reference to the company's business in China during the past year without saying that the great results obtained were principally owing to the labours of the managing director, Captain E. Suenson, and to the manner in which he had conducted these negotiations, but great thanks were also due to the company's leading officers in China for the ability shown on this occasion, and, in fact, all members of the company's staff engaged in this business had done their best to further the interests of the company. The directors did not therefore hesitate to propose that the company's contribution to the pension fund of the staff should for the past year be increased to Kr. 20,000 (£1,111 2s. 3d.), about the double of previous years. Finally, the chairman remarked that he regretted to find that the advantages gained in China by the company had given rise to a certain feeling of dissatisfaction and jealousy amongst persons of other nationalities residing in China, and that even diplomatic assistance was said to have been obtained in order to oppose the company's interests. Hitherto the latter had been without avail, and no doubt the antagonistic feelings would disappear as soon as it became evident that the privileges accorded to the company resulted in advantages to the opponents themselves, and to the world at large. The company had also had their attention fixed upon the advantage of the introduction of the telephone in China, and had therefore made arrangements with the Oriental Telephone Company (Limited) jointly to carry on this business. Telephone exchanges were now already established in Shanghai and Hong Kong.

In referring to general topics, the chairman first of all referred to the great loss the company had sustained by the death of Mr. H. J. Pallisen of St. Petersburg. Mr. Pallisen had been intimately connected with the Company since its formation, and had always, as its representative in Russia, taken the greatest interest in all its undertakings. He would be succeeded by Captain W. de Hedemann, who had hitherto transacted agency business for the company at St. Petersburg. The successors of Mr. Pallisen's firm would continue to be the company's bankers. The company had acquired new and more suitable premises for its stations at Libau, Nystad and Shanghai. With regard to the latter it might be mentioned that they are situated in a very convenient and central position, and that the Chinese Government station is located in the same. The company's instrument workshops at Copenhagen had been largely extended, and could now favourably compare with the best foreign establishments. Reverting to the accounts, the chairman referred to the balance sheet, and showed that the result of this year's working was that after £55,555 11s. 1d. had been added to the reserve fund, which fund now, after the outgoings of the past year would stand at £210,151 7s. 10d., and, after 7½ per cent. had been paid to the shareholders, a cash balance of £19,688 18s. 7d. would be carried forward to next account. Without discussion, the report was then unanimously adopted, the accounts were passed, and discharge given to the board of directors. The retiring director, Moritz G. Melchior, Esq., was re-elected. The shareholders' auditors, His Excellency Admiral Bille and A. Berner, Esq., were also re-elected. A shareholder proposed a vote of thanks to the board of directors generally, but especially to the chairman (C. F. Tietgen, Esq.), and to the managing director (Captain E. Suenson), for the great ability shown in the management of the company's business. The resolution being put to the meeting, was heartily responded to.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices April 26.		Business Done Week Ending April 26. Highest.	Lowest
Anglo-American	54,	54¼	54¼	53¾
Do. Preferred	84½,	85½	85½	83¾
Do. Deferred	24½,	25	25½	24⅛
Brazil Submarine	10¾,	11⅛	11⅛	11
Cuba	8⅛,	9	9	9
Do. Preference	15½,	16½	—	—
Direct Spanish	6,	6¼	6 7-16	6¼
Do. Preference	15,	16	15½	15¼
Direct United States Cable	11⅛,	11½	11½	11⅛
Eastern Telegraph	10,	10¼	10¼	10 1-16
Do. 6 per Cent. Preference	12⅛,	13	13 1-16	12 13-16
Do. 5 per Cent. Debentures, 1899	102,	107	105	105
Eastern Extension	11⅛,	11⅜	11 11-16	11⅛
German Union	9⅛,	10¼	—	—
Globe Telegraph and Trust Company	6⅛,	6⅝	6⅝	6⅛
Do. Preference	12⅛,	12⅝	12 7-16	12⅛
Great Northern	12⅞,	13⅛	13⅛	12⅝
Indo-European	30,	31	30½	30⅛
Mediterranean Extension	2,	2⅛	—	—
Do. Preference	8⅞,	9⅛	—	—
Reuter's	13¼,	13⅜	14⅛	13⅛
Submarine	260,	270	265	265
West India and Panama	1⅞,	2	2	1⅞
Do. 1st Preference	8⅛,	9	8⅜	8 7-16
Western Brazilian	8,	8⅛	8⅛	8⅛
West. Union 7 per Cent. 1st Mortgage	124,	129	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	105	105

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1⅛	1 9-16	1⅛
Oriental	⅜,	½	7-16	⅜
United Telephone	13⅛,	13⅜	13⅜	13 5-16

ELECTRIC LIGHT.

Eastern Electric Light and Power	4⅛,	4⅜	4 15-16	4 7-16
Electric Light and Power	⅛,	¼	⅜	9-16
Anglo-American Brush	11¾,	12¼	12 5-16	11¼

TRAFFIC RECEIPTS FOR MARCH, 1882.

Companies.	March, 1882.	March, 1881.	Increase.	Decrease
Cuba Submarine Company	4,000	3,124	876	—
Direct Spanish Telegraph Company	2,332	1,492	840	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,677	29,661	4,016	—
Eastern Telegraph Company	48,824	51,206	—	2,382
Great Northern Telegraph Company	19,680	—	—	—
West Coast of America Telegraph Company	3,490	1,635	1,855	—

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SLIP

SOCIETY OF ARTS PATENT BILL.—This Bill was read a second time in the House of Commons on Friday, the 28th April.

CABLE INTERRUPTED.—The Direct Spanish Telegraph Company notify that their Falmouth-Bilbao cable is interrupted.

ROYAL SOCIETY.—On Thursday a paper was to have been read before this society by Lord Rayleigh, F.R.S., "On the Specific Resistance of Mercury."

STRAND BOARD OF WORKS.—This board have resolved to enter into negotiations with the Edison Electric Light Company with a view to lighting their board room.

ELECTRIC LIGHT IN OTTAWA (CANADA).—Lighting the upper town of Ottawa by electric light was tried on April 7, and resulted successfully.—*Colonies and India.*

ELECTRIC LIGHT FOR CAMBERWELL.—The Camberwell Vestry have resolved to obtain tenders from six companies for lighting a portion of High-street, Peckham, by electric light.

THE EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1882, amounted to £42,667, against £45,289 in the corresponding period of 1881.

A USEFUL GIFT.—The trustees of the British Museum have presented to the East London Postal and Telegraph Employés' Circulating Library a number of valuable works of reference.

THE MAGAZINES.—*Modern Thought* for May contains an article on the Crystal Palace Electrical Exhibition, signed "Cosmopolite." Mr. W. H. Preece continues his paper on "The Age of Electricity" in *Time.*

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1882, amounted to £29,269, against £26,746 for the corresponding period of 1881, being an increase of £2,523.

MILITARY NEWS.—Lieutenant S. M'M. Maycock, Royal Engineers, has been appointed an assistant-instructor in telegraphy at the School of Military Engineering, Chatham, vice Lieutenant L. Darwin, Royal Engineers.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The seventeenth half-yearly general meeting of this company will be held at the Cannon-street Hotel, on the 12th inst., at 2 p.m. The directors' report will be found in another column.

SS. "SILVERTOWN."—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram informing them of the safe arrival of their ss. "Silvertown," Mr. M. H. Gray engineer-in-charge, at Lota Chili, on the 24th ult. All well on board.

THE TELEPHONE CASE.—The case of the United Telephone Company v. Harrison, Cox-Walker, and Co., is still proceeding, and seems likely to last well into next week. We have a verbatim report of the case, the most important parts of which will be given in due course.

FIRE RISKS AND ELECTRIC LIGHTING.—A paper on this subject was read on Wednesday at the Society of Arts by Mr. Thomas Bolas, F.C.S., and the first of a series of lectures on the same subject by Mr. Day were begun at King's College on the same day. We shall allude further to this matter in another issue.

A SHIP FIRED BY LIGHTNING.—A telegram received from Lloyd's agent at Galveston in the early part of this week stated that the "Ceres" (German brig), from Galveston bound for Bremen, laden with cotton, had put back to Galveston with cargo on fire, having been struck by lightning. The vessel had been filled with water and the fire extinguished.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The next meeting of this society will be held at 25, Great George-street, on Thursday, May 11th, 1882, when the following papers will be read:—(1) "Measuring Instruments used in Electric Lighting and Transmission of Power," (2) "The Technical Education of an Electrical Engineer," by Professors W. E. Ayrton and John Perry.

UNDERGROUND TELEPHONE CABLE.—An American contemporary says:—"The American Bell Telephone Company successfully laid thirty-eight sections of underground cable between Attleboro' and West Mansfield, Massachusetts, on the 16th of April. There are 530ft. to a section. The cable contains twenty-one conductors, encased in heavy lead pipe, and is laid between the tracks of the Boston and Providence road."

ANOTHER ELECTRIC LIGHT COMPANY.—The South-Eastern (Brush) Electric Light and Power Company is announced, with a capital of £100,000 in 20,000 shares. The Company has acquired the right to use the various licenses and inventions of the Anglo-American Brush Corporation, together with the Lane-Fox incandescent lamp, in the counties of Surrey, Kent, and Essex, excluding the metropolitan postal districts.

SUBMABINE CABLES TRUST.—The eleventh ordinary annual meeting of this Trust will be held at No. 66, Old Broad-street, E.C., on the 9th of May, at two p.m. According to the report the revenue for the twelve months, including the balance brought from last year's accounts—viz., £777, and the dividend on Eastern Extension Shares (£2,323) declared prior to the 15th, but not paid until the 20th inst., amounted to £23,535. The expenses of the Trust amounted to £1,316. Payment of two coupons at the usual rate of 6 per cent per annum has absorbed £20,282, and the balance of £1,837 is carried forward.

ELECTRIC LIGHT FOR CAPE TOWN.—The Cape Government are thinking of lighting the Houses of Parliament by electric lights. Possibly this is what has led a contemporary to state that the Government has "ordered from the Edison Foreign Electric Light Company complete apparatus which will be used to illuminate the Houses of Parliament at Cape Town." We know that a representative of the Edison Company has proceeded to Cape Town, and it is very probable that they will eventually light the Houses of Parliament in question, but we are inclined to doubt the absolute authenticity of the above statement.

ELECTRIC LIGHTING BILLS.—In the House of Commons on Friday, the 28th April, the following Bills were referred to the Select Committee on the Electric Lighting Bill:—Anglo-American Brush Electric Light Corporation, Electric Light and Power Generator Company, British Electric Light Company, Dublin Electric Light and Power Company, Siemens Brothers and Company (Electric Lighting), Edison's Electric Lighting, Aberdeen Lighting, and Dundee Lighting, and it was agreed that petitions against these Bills should be referred

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to the Committee. On Monday, the 1st inst., the Siemens Bill was read a second time.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended April 30 are £3,219, as compared with £2,946 in the corresponding period of 1881. The report of the company for the past six months shows that the gross revenue was £34,041, and the expenses £25,016, leaving a balance of £8,955, which, with £8,708 brought forward, makes a total of 17,663. The directors recommend the payment of 6s. per share on account of arrears of dividend on the first preference shares, and, after adding £5,000 to the reserve account, carry forward a balance of £2,294.

An Electrical Storage Company.—The prospectus has been issued of the Indian and Oriental Electrical Storage Company, with a capital of £400,000, in £5 shares. First issue £200,000, of which 10,000 shares are reserved for future payment to the vendors at the option of the company. This company has acquired from the Electrical Power Storage Company their patents or rights for India, Ceylon, the Straits Settlements, Egypt, and Malta, in the secondary batteries of Messrs. Sellon, Swan, and Volckmar. Amongst the directors are Ernest Noel, Esq., M.P., and Right Hon. Earl Crawford. The consulting electrician is Mr. Latimer Clarke. The company's offices are at Winchester House, Old Broad-street, E.C., Mr. H. C. Heywood being secretary.

Nickel and other Plating.—The Birmingham correspondent of the *Ironmonger* says:—"In no branch of our local industry have greater advances been made during the past few years than in that devoted to electro-plating. Since the introduction, indeed, of dynamo machines in substitution for batteries quite a revolution has been effected in the trade; and whether for silver, nickel, brass, or copper-plating, the advantages of these machines in regard both to economy and efficiency are so great that they have become practically indispensable to everyone who aspires to make plating on a large scale a commercial success." The same authority also states that there are now some 6,000 to 7,000 Bunsen cells in use in the nickel-plating business.

Electric Light on Shipboard.—The steamship, "Austral," the latest addition to the Orient fleet of steamers, has been fitted with electric lights by Messrs. Siemens Brothers. The whole of the public rooms, engine room, pantries, and passage ways are lighted by this means. Five Siemens arc lights are used in the engine room and four on deck, whilst 170 Swan lamps do duty elsewhere. The current is supplied by two Siemens alternate current dynamos, each driven by a separate engine strong enough to drive them both. The total candle-power of the arc lights is reckoned at 3,600, and that of the Swan lamps at 3,400, being a total of 7,000 candles. The "Austral" is at present in the Albert Dock, where we believe she can be inspected by the public.

The Gale.—The storm which raged on Saturday and Sunday seems to have done a good deal of damage to telegraphic wires, as is invariably the case when we get a good hard south-westerly wind, let alone such a gale as that we speak of. In many instances the wires are reported as broken by falling trees—notably at Exeter and Uxbridge. At the former place the telegraph wires were broken down in every direction; and close to the city the fall of several elm trees carried away the main wires to the south, including those connecting Brest, Jersey, the Spanish, the Jay Gould, and other cables. The Royal Engineers were soon on the spot executing repairs, but the damage was stated to be so extensive that anything like complete communication could not be restored for a day or two.

New Company.—The prospectus has been issued of the Gülcher Electric Light and Power Company (Limited), which has been formed to purchase and work the system of electric lighting patented by Mr. R. J. Gülcher for Great Britain and Ireland, the Channel Islands, the Isle of Man, and also to purchase the right to take out the patents for India and the colonies. The capital of the company is £300,000 in 60,000 shares of £5 each, 15,000 of which are issued as fully paid-up shares to the vendors (Messrs. Robert Jacob Gülcher and Lorentz Albert Groth), leaving 45,000 shares for public subscription. The consulting engineers are Sir S. Canning and R. Sabine, Esq., Mr. R. J. Gülcher acting as electrician. The company's offices are at 121 Bishopsgate-street, E.C., Mr. C. B. Charlewood being secretary pro. tem.

City Telegraph Boys.—Mr. S. A. Blackwood, C. B., Secretary to the General Post Office, presided on Thursday week at a meeting of these boys, to the number of about 250, at the rooms of the Young Men's Christian Association in Aldersgate-street. After a substantial tea the chairman addressed the boys, and was followed by Mr. Johnston, Postmaster of the City, who, in speaking of the importance of the telegraph boy as a factor in the commercial system, said that the boys then assembled had delivered close upon two millions of telegrams in the City during the past year. He remarked, too, that meetings of the kind were calculated to be of the greatest importance to the welfare of the boys and the interests of the public, whose servants they were. The proceedings were enlivened by the performances of an excellent choir and a series of dissolving views of Old London.

Electric Lighting at West Bromwich.—At a recent *soirée* of the West Bromwich Institute, held at the Town Hall, some Swan lamps were exhibited by Messrs. Smith and Chamberlain, of the Solar Works, Birmingham. The installation consisted of a Siemens dynamo-electric machine, and about thirty Swan incandescent lamps. These were shown principally in the board room of the hall, and were in part adapted to display the pictures which had been lent for the occasion. All kinds of bracket lamps with and without mirrors were shown, in illustration of the adaptability of the light for domestic use. A lamp was also shown burning under water, with gold fish swimming round. It is stated that Messrs. Smith and Chamberlain have for many months past lighted a portion of their works with the Swan lamp, and they find that for every 1,000 cubic feet of gas exploded in a gas engine they get the light of 2,000 cubic feet burnt in the ordinary way.

Leeds.—The committee deputed by the Leeds Corporation to visit the Crystal Palace Exhibition have issued their report, which is very elaborate, and includes some 136 pages of print. The report states that "the deputation are of opinion that the 'arc' lamps are well adapted for the illumination of very large areas, either indoor or in public places, where a powerful light is desired. They were much impressed with the success of the incandescent lamp installations, and of the adaptability of this class of lamp for indoor lighting of great purity, of its value as a bright and steady illuminator, perfectly under control, and free from heat, carbonic acid, or smoke. It is most suitable for large rooms, picture galleries, or reading rooms, and for the many purposes to which the more powerful arc light may be said to be unsuitable. Portions of the new Municipal Buildings could, no doubt, be successfully lighted with this class of lamp, which, if used in the library, would tend greatly to the comfort of the reading public and the preservation of the books." The report has been compiled by Mr. Joliffe.

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Electric Light in Manchester.—At a fancy dress ball given by the Bachelors in the Assembly Rooms, Manchester, last week, was witnessed a large display of incandescent lighting. The suite of rooms were lit by the British Electric Light Company with their "British" lamps and Gramme machines. The ball room was lit with 150 incandescent lamps, fitted on to the glass chandeliers, the effect of which was novel and brilliant, showing off the dresses and flowers to great perfection and keeping the room at a cooler temperature than when lit by gas, to the comfort of the guests. The refreshment room was illuminated by 32 lamps hung in Venetian shades of different colours. The reception room electrolier, specially designed for the occasion, was also very effective. The power for driving the dynamo-machines was obtained from Messrs. Marshall and Son's portable engines, placed in the yard. The whole of the arrangements were carried out by Messrs. H. Bury and G. Tyndall, the company's representatives for the district, in the short space of eight days.

Electric Lighting for the City.—Advertisements have been issued by the Commissioners of Sewers inviting tenders for lighting a portion of the City. The area to be lighted has been divided into four districts, which include a portion of the City formerly lighted by Messrs. Siemens. The streets to be lighted are as follow:—London Bridge, Queen-street (between Queen Victoria-street and Cheapside), Cheapside (between King-street and Poultry), King-street, Guildhall-yard, Poultry, Mansion House-street, Royal Exchange (open space in front of), King William-street, Adelaide-place, Lombard-street, Fenchurch-street, Aldgate, Aldgate High-street, Leadenhall-street, Cornhill, Bishopsgate-street (between Cornhill and Liverpool-street), Liverpool-street (between Bishopsgate-street and New Broad-street), New Broad-street, Old Broad-street, Threadneedle-street (between Old Broad-street and the front of the Royal Exchange), St. Martin's-le-Grand, Aldersgate-street, Long-lane (between Aldersgate-street and Smithfield), Smithfield (east side between Long-lane and Giltspur-street), Giltspur-street, Newgate-street. A plan of these streets can be seen at the Sewers Office, Guildhall. Printed conditions of the contract can be had on payment of two guineas at the same office. The tenders are to state the terms for the lights for twelve months from the 1st October, burning from sunset to sunrise, and are to be sent to Mr. H. Blake, principal clerk, Sewers Office, Guildhall, by two p.m., on 12th May, at which time persons tendering, or their agents, are to attend.

Thunderstorms.—Accrington was visited by a heavy thunderstorm on Monday, accompanied by showers of hail and rain. The wind rapidly shifted from east to south, the air being remarkably cold. At Pentwgraig, Rhondda Valley, a mare and colt, valued at £50, were killed by lightning during a terrific thunderstorm which visited the district during the afternoon of that day. Severe thunderstorms are also reported as having taken place in the western and midland counties on Wednesday. During a heavy thunderstorm at Tenbury, Worcester, the railway station was completely wrecked by a whirlwind. The roof was stripped and lifted out of position, the windows and doors blown away, and two men in a signal box were carried some twenty yards by the wind. At Burslem, in Staffordshire, three houses in different parts of the town were struck by lightning. Severe storms of thunder and lightning are also reported from Wolverhampton, Cheshire, Herefordshire, and Sheffield, though no loss of life appears to have taken place. At Wellingborough, in Northamptonshire, however, the lightning struck a man named Wilman, whilst engaged in milking some cows a short distance from the town, and killed him on the spot. At Stockport the lightning struck a chimney stack on an hotel, setting fire to the roof by melting a gas pipe. Very severe thunderstorms also visited Blackburn, Dover, Hull, Nottingham, and Wrexham. In Durham, during a severe thunderstorm on Tuesday, Wolviston parish church, situate between Stockton and West Hartlepool, was struck by lightning, and so seriously cracked and shaken that it is believed it will be necessary to take down and rebuild a large portion of the edifice.

Gas Opposition to the Electric Lighting Bill.—The following remarks, from an article in the *Journal of Gas Lighting*, may be taken as indicating the line that will be pursued by the opponents to the Electric Lighting Bill. Our contemporary says:—"It is to be urged with all possible force that electric lighting, as a regular system, is not yet sufficiently perfected to be taken up by public authorities having a practically unlimited control of the public purse. The drift of this objection is obvious. Speculative electricians are plausible and not over scrupulous in pushing their trade; local authorities are ignorant of such matters, impressionable to irresponsible public clamour, and sometimes badly dispositioned towards their local gas companies. Supposing, now, that a town council in this condition, eagerly looking for means of damaging the value of the local gas undertaking, obtains from the Board of Trade the power of supplying electricity in the very best and most conspicuous part of their town. The Health Committee at this juncture fortunately want a new steam-engine and boiler at their depot; this, of course, affords an opportunity for getting machinery capable of driving dynamos without any declared additional cost. About the same time also the paving committee find it necessary to repair the roadway in the selected district, and the line-wires are then laid without a heavy charge appearing in the accounts. By such means, and aided by a little clever manipulation and distribution of the working charges, the cost of the electric lighting may be made to appear low enough to seriously affect the prospects of the gas company, taken in addition to the fact of the best lighting in the town having been forcibly given over to the new system. The gas interest cannot and does not object to the introduction of electric or any other kind of lighting by trading concerns using specially raised capital, and carrying on operations without restrictions, but also without favour. What is objected to is that, having conquered a certain position by dint of long struggling, and holding the same by right of the performance of certain statutory duties, gas companies should be exposed to attack—not by other traders similarly situated, but by public bodies entrusted with wide powers of every kind, financial and material, which were never originally intended to enable them to compete with private enterprise. With respect to the danger of interference with gas companies' property, all that has now to be said is that the proceedings of electric light speculators, municipal or others, need more effectual regulation. The Bill avowedly contemplates the vesting of discretionary powers in the Board of Trade for declaring where electric lighting shall be compulsory and where optional with the undertakers. It certainly appears unfair that, while the best paying districts are given to the electricians, who may be privileged to select their customers, the gas company must still maintain plant and staff for the purpose of supplying the rejected of their rivals, and for keeping up an occasional service whenever the latter get into trouble."

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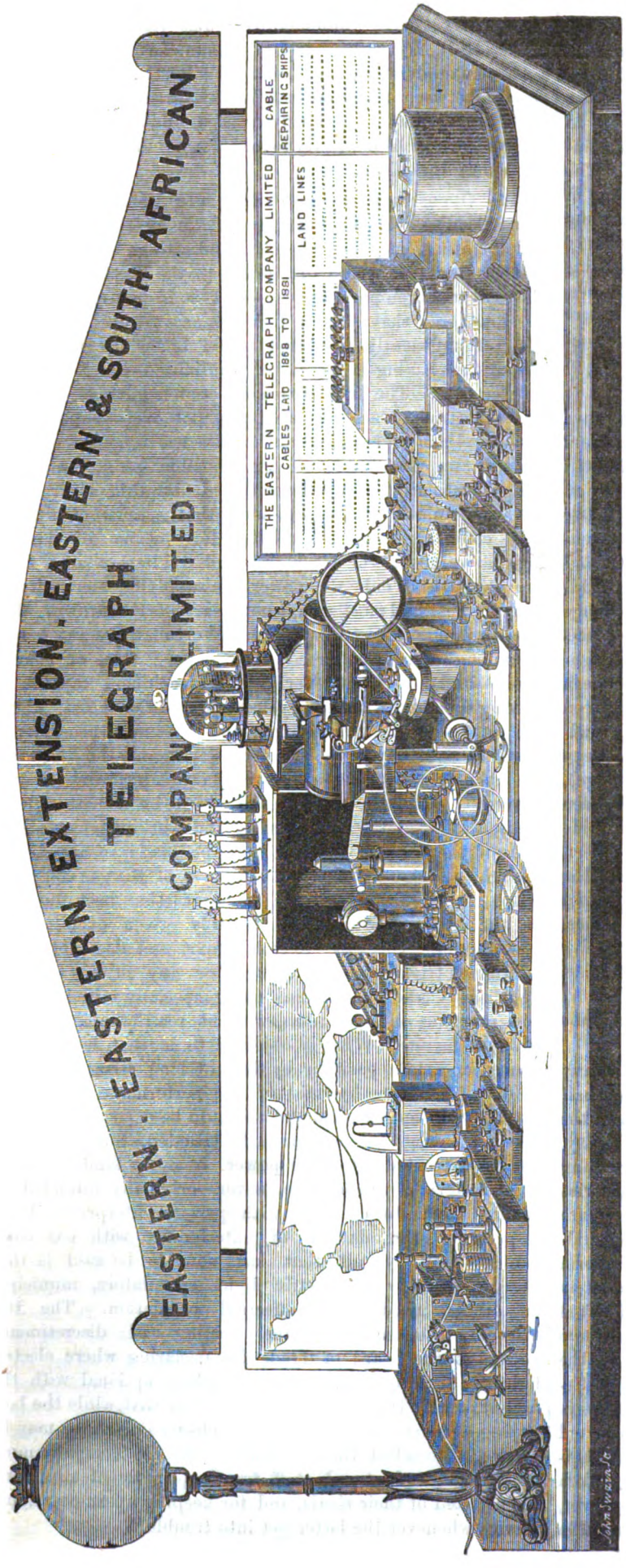
CRYSTAL PALACE EXHIBITION.

The Eastern Telegraph Company's Exhibits.


EASTERN, EASTERN EXTENSION, EASTERN & SOUTH AFRICAN TELEGRAPH COMPANY LIMITED.
THE EASTERN TELEGRAPH COMPANY LIMITED
CABLES LAID 1868 TO 1881
LAND LINES
CABLE REPAIRING SHIPS

It was Macaulay, in his Essay on Lord Clive, who first gave to our minds in our schoolboy days an adequate idea of the troubles which beset communication with India in the middle of the eighteenth century. "Clive's voyage," says the essayist, "was unusually tedious, even for that age. The ship remained some months at the Brazils, when the young adventurer picked up some knowledge of Portuguese, and spent all his pocket money." Probably it was the penniless condition of Clive—no exceptional state, however, for a schoolboy's finances—that impressed upon our memory the time which then elapsed during a voyage to India. A century later this time was greatly diminished, but was still too long for business purposes. It has been reserved for the last quarter of a century to solve the problem and defy time by connecting this great dependency with England. Writing on telegraphic communication with India in 1857, Mr. Francis Gisborne, some of whose words we have quoted before, said, "No one sends a message in England if the news will keep till next morning, when the less expensive post office will bring it to its destination; and few messages are sent which are to reach their destination after ordinary business hours. But as between England and India the telegraph will have no post-office to compete with; everything that will not keep for thirty days will be transmitted by telegraph; thus by force of example and by habit, all arrangements coming insensibly to be framed on the assumption that the instantaneous means of communication will be resorted to, will speedily raise the telegraph into a connecting link between England and India of the most vital importance and extensive application." It will not be necessary to enter into all the difficulties which were encountered and overcome before we had telegraphic communication with India. Suffice it to say that we have now two routes controlled respectively by the Eastern Telegraph Company and the Indo-European Telegraph Company. The former Company is the most powerful and the most extensive submarine telegraph corporation in the world. Its position is better understood when it is noted that its shares are quoted above par. The Company, however, was not in the first instance launched to complete the cable communication with India, but was formed in 1872 by the amalgamation and absorption of the Falmouth, Gibraltar, and Malta Telegraph Company, the Anglo-Mediterranean Telegraph Company, the British Indian Submarine Telegraph Company, and the Marseilles, Algiers, and Malta Telegraph Company.

By the arrangement then entered into the Eastern Telegraph Company became the owners of the following cables, which had been laid down by the Telegraph Construction and Maintenance Company. Falmouth to Lisbon, Lisbon to Gibraltar, Gibraltar to Malta, Malta to Alexandria, Alexandria to Cairo and Suez (land line), Suez to Aden, Aden to Bombay, and Marseilles to Bona, with a network of cables in the Levant. The new Company commenced its operations in June, 1872. In 1873 a duplicate cable was laid for the Company by the Telegraph Construction and Maintenance Company from England to Lisbon, touching at Vigo. In 1874 cable extensions were made in the Levant to Syra and Smyrna, and from Candia to Rhodes, &c. In 1876 a duplicate cable was laid from Suez to Aden and Bombay, and in the same year Marseilles and Bona were connected by a second cable belonging to the Company, thus

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completing the Company's duplicate lines to India. In 1878 a working and joint-purse traffic agreement was entered into between the Indo-European Government Telegraph Department, the Indo-European Telegraph Company, and the Eastern Telegraph Company, as to Indian and Trans-Indian traffic. In the same year the Muirhead duplex system of working the cables was introduced.

The Company subsequently extended its Levant system to Constantinople, Tenedos, Besika Bay, Salonica, and Syra to Candia under contracts with Her Majesty's Government and the Government of His Imperial Majesty the Sultan of Turkey, and the Company acquired the shares in the Black Sea Telegraph Company, the cable from Constantinople to Odessa being worked as part of the Eastern Company's system. In accordance with arrangements made with Her Majesty's Government, the Company also connected Cyprus and Alexandria by cable, and completed a system of land telegraphs in that island.

In 1879 the Company entered into an agreement with the Lords Commissioners of Her Majesty's Treasury and the Telegraph Construction and Maintenance Company, and made subsidiary contracts with the Colonial Government of the Cape of Good Hope and Natal, the Portuguese Government, and the Sultan of Zanzibar, for the establishment of cable communication between this Company's station at Aden and Natal, *vid* Zanzibar, Mozambique, and Delagoa Bay, a separate Company being formed for that purpose, called the Eastern and South African Telegraph Company (Limited), having a share capital of £400,000, and a mortgage debenture capital of £550,000. But as the entire management and working of the cables is in the hands of the Eastern Telegraph Company, and the traffic passing over its wires from Aden, the new lines practically form an important addition to this Company's system.

The laying of the cables of the South African Company was completed on the 29th December, 1879.

The Eastern Company has a total length of 16394·932 miles of cable, with 815·482 miles of land lines, and 39·13 subterranean lines, to which we ought to add the Eastern and South African Company's cables, 3853·84 miles, giving a grand total of 21073·384 miles to telegraph line. The system, indeed, is incomplete unless we add the cables of the Eastern Extension Company, which, with 24 miles of land line, has 10454·107 miles of line, so that the Eastern network of telegraphs under the control of these companies extends to no less than 31527·491 miles.

The exhibits of the Eastern Company, whose stand we now illustrate, consist principally of the various instruments used in telegraph work. In the centre, a worthy trophy of mechanical ingenuity and the adaptation of scientific knowledge to practical purposes, is a Thomson's Recorder. This beautiful instrument has been placed in circuit with a similar instrument shown by the School of Telegraphy, and constantly worked during the Exhibition, so that for the first time it has been possible for those interested in the subject to see how messages are transmitted by such means. We shall describe these instruments in detail in future numbers, so that at present we merely call attention to them. No one who visits the Exhibition should miss seeing these instruments, for such opportunities come but seldom, and it may be years before the public will again be able to see them at work. Besides this wonderfully delicate centrepiece, there will be found to the left specimens of Morse instruments, of galvanometers, of resistance boxes, and throughout the stand "keys" of various kinds, all adapted for special purposes; to the right will be found some exceedingly neat and simple switching apparatus, designed to facilitate working, like so much of his apparatus, by Mr. Saunders, the chief electrician of the Company. Altogether these stands of the cable companies in connection with the immediately adjoining stand of the Telegraph Construction and Maintainance Company are well worth a close and careful examination. Here we have specimens of most of the cables of the world, the apparatus used for their working, and the numerous enemies that assail them.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

On Thursday, 27th April, Mr. A. Stroh explained to the members of this Society the nature and results of his recent experiments in relation to the phenomena of attraction and repulsion by sonorous vibrations, and the resemblance they bear to magnetic attraction and repulsion. For reasons which will appear presently it is impossible to do justice to what took place on this very memorable occasion when, by general consent, one of the most brilliant of experimental lectures was delivered. Mr. Stroh commenced by warning his audience that what he was about to

FIG 1

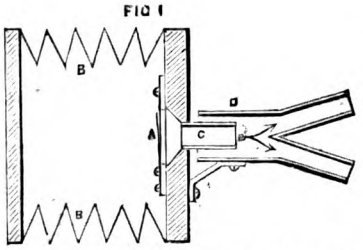
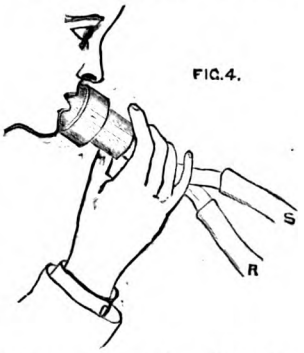


FIG.4.



say had little to do with either electricity or magnetism directly; but the phenomena to which he had lately been giving his attention so closely resembled those of magnetism that an account of them could hardly fail to be interesting, at least to members of this Society. Moreover, the properties of magnetism were still so mysterious that much importance would naturally attach to anything tending to throw light upon them. Every one who had witnessed Dr. Bjerkness's beautiful appliances at the Paris

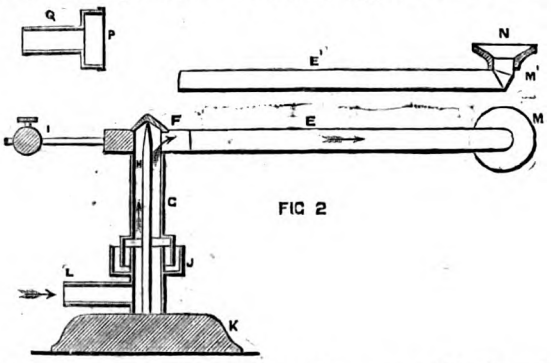
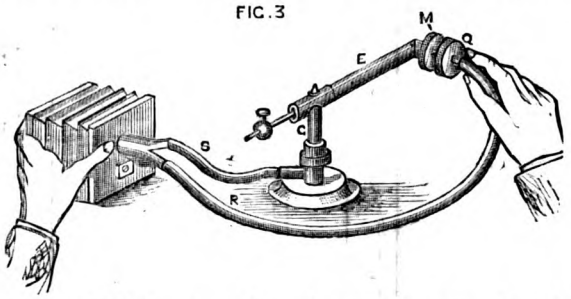


FIG 2

Exhibition had felt this to be the case. The beauty and ingenuity of those experiments could not, he considered, be too highly praised. Not only did the attraction and repulsion obtained by means of the pulsating drums resemble magnetism, but the lines of force were also apparently similar. A new road was, therefore, opened to the investigation of magnetic phenomena; and he had been unable to resist the temptation of pursuing this new road,

FIG.3



but he had used different media. It would be remembered that Dr. Bjerkness's illustrations were in water, and Mr. Stroh's first idea was to try to produce them in air. His earliest attempts with this elastic medium were most encouraging, and he was led finally to make the various apparatus which he here exhibited. In order to produce the requisite vibrations, he constructed an air-box, or bellows, easily manipulated, and the compression of which produced a musical note, serving to set up the vibrations required in the experiments. From this air chamber a pair of forked tubes projected, at the junction of which was the musical reed just mentioned, so that the vibrations were equally divided

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between the two outlets. The necessity for this equal division was one of the results early arrived at by Mr. Stroh. He found that none of the looked-for phenomena were obtainable when the notes were of different pitch. The pitch itself was immaterial, though, of course, some membranes favoured one pitch rather

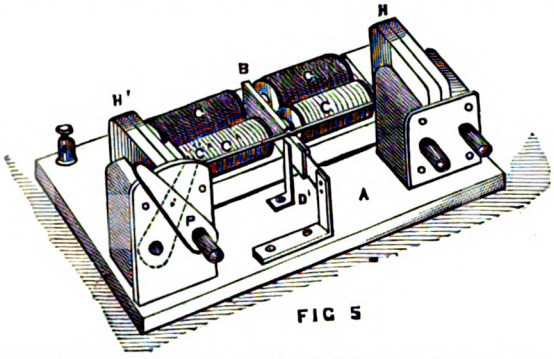


FIG 5

than another, and the effects were modified proportionately; but with identical pitch the action was invariable in character. Fig. 1. A is an ordinary harmonium reed, with any suitable bellows, B, while C is a short brass tube terminating the aperture over which A is placed. A larger brass tube, D, is fixed so as to partly cover C, and to allow an air passage between, D terminating in two branches, as shown, on which tubes can be placed to communicate with the instrument shown in Fig. 2. This latter consists of a light tube, E, of paper or similar material fitting closely on the nozzle F, which is part of a brass tube, G, having at its upper extremity a cup resting on a steel point, H. Opposite F is a small weight, I, used to counterbalance tube E, &c. One end of G dips into mercury in the cup J. Below J is an opening, L, for a connecting tube. The stand K is of brass. Inside G is a perforated guide plate with a bearing fitting over the steel pin H. The whole arrangement is to conduct vibrations without loss, while allowing the tubes G and E to revolve on the steel pin. E is bent at an angle of about 90deg., and carries the drum M M', on which is an india rubber membrane, N. A similar diaphragm is also fixed at P on Q. Fig. 3 shows connecting tubes S R, and the sum of the length of tubes S G E is equal to length of tube R.

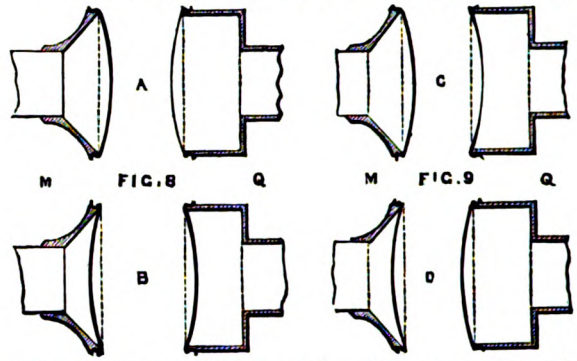
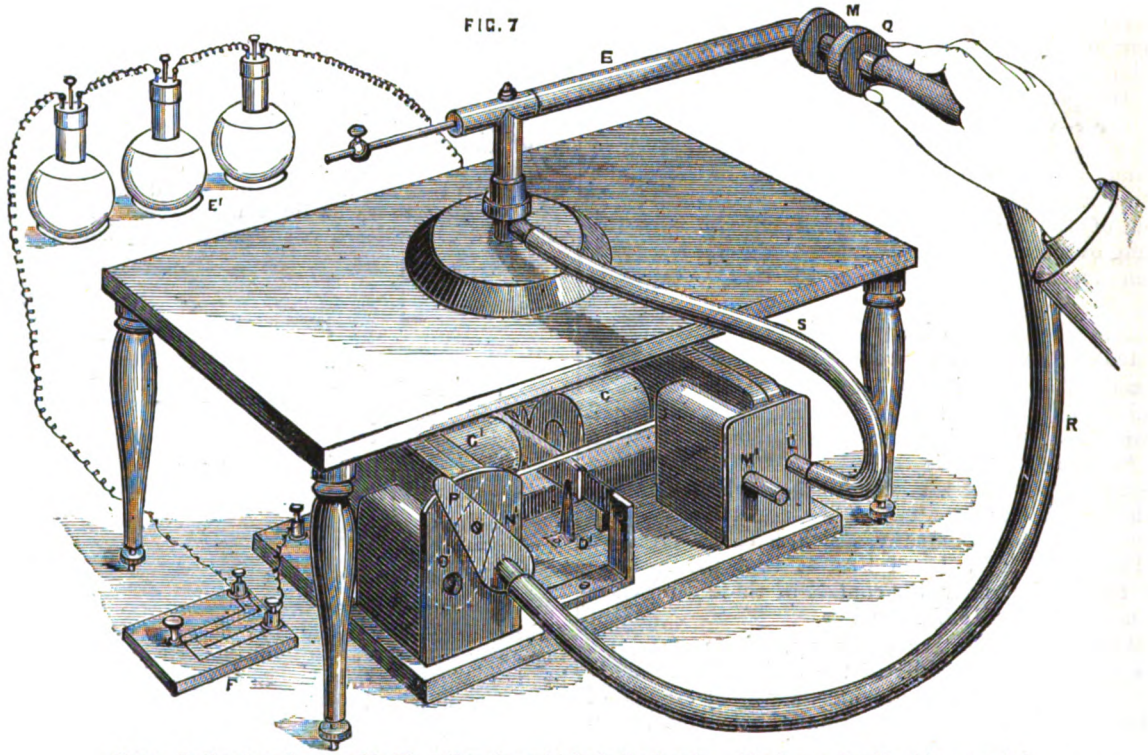


FIG.8 FIG.9

FIG. 7



NOTE.—In the above figure and in Fig. 3 there is a mistake in the drawing. The drums should not be connected.

It will thus be seen that we have a tube with membrane that could be handled and applied at pleasure, and a second tube with membrane capable of revolving in one direction or the other.

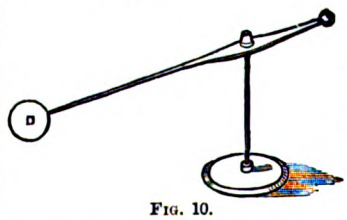


FIG. 10.

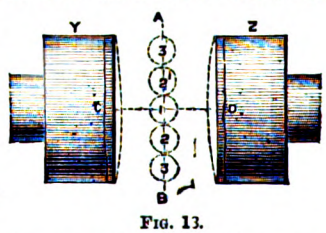
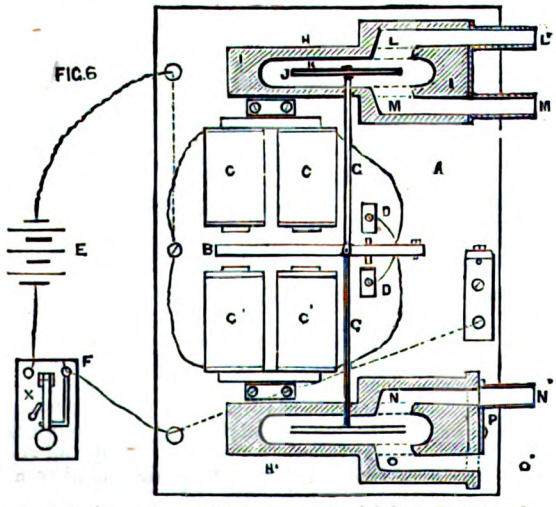


FIG. 13.

On working the bellows the membranes at the respective extremities of the two tubes vibrated similarly. All this being arranged, the experimenter brought the free membrane near to the membrane of the balance, and on sounding a note the latter was attracted, just as if it had been a magnetic needle horizontally swung. The bend of the short tube, it will be understood, is necessary to allow of the faces of the two membranes being presented to each other in the plane of motion. This was the first

FIG.6



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experiment, and giving as it did the key to all the rest, it was received with loud applause, which was renewed when the lecturer, dispensing with the musical reed, applied his voice (Fig. 4) to the tubes, and produced exactly the same effects, varying only in strength with his varying tones.

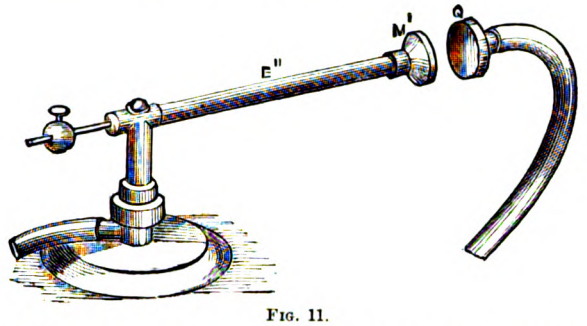

FIG. 11.

Mr. Stroh then showed the effects of vibrations of dissimilar phase. In the experiments just described, the pulsations were, of course, of like phase—that is to say, when one membrane bulged out so did the other, and both recoiled in like manner at the same moment. But while maintaining the same pitch it was shifted to or connected with either of the other ends. It is obvious that a movement of B in the direction of the magnet C will cause air to be expelled from the air passage L and N, and at the same time to be sucked in by M and O, and *vice versâ*. Fig. 7 shows an arrangement of the apparatus found convenient to obtain good results. The armature B being thrown into vibration, the two pumps compress the air in both tubes at the same time, and the membranes of the drums M and Q move outwards, as in Fig. 8A or as in Fig. 8B. If the lever P be moved to O'' there will be compression in one tube and expansion in the other, the result in the diaphragm being as shown in Figs. 9C and 9D.

Thus the phenomena of attraction and repulsion both were imitated in the completest manner—attraction when the phases were alike, repulsion when unlike. (The apparent reversal here of the effects of similar and dissimilar polarity of magnetism was remarked upon later on.) Dispensing with one of the manipulating tubes, Mr. Stroh then showed that the approach of any body, such as a piece of cardboard, or the lecturer's hand, near to the diaphram of the swinging tube, caused it to be attracted, just as a magnetic needle would be by a piece of soft iron. The attraction and repulsion of two magnets resemble the effects described and shown by Mr. Stroh, with this difference, that with the membranes vibrating in the *same* phase attraction takes place, and in the *opposite* phase repulsion, while with magnets we are accustomed to hear that similar poles repel and dissimilar poles

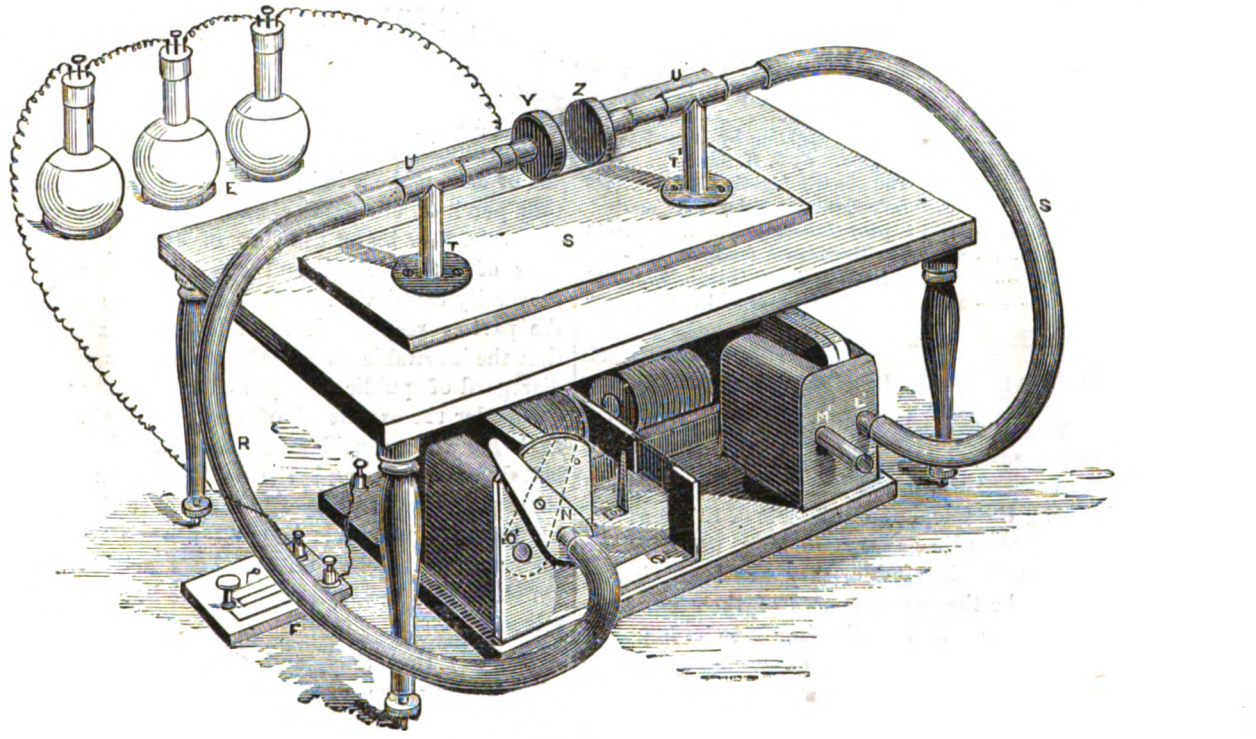

FIG. 12.

still possible to obtain dissimilar or unlike phase of vibration. Imagining the air particles in the tubes to be subject to successive condensation and rarefaction, by giving the impulse in one tube a start of that in the other tube, the effect would be to cause one membrane to recoil when the other advanced, one being convex when the other was concave, and *vice versâ*. This was called unlike phase. For the experiments which followed it was desirable to change the phase of vibrations quickly from like to unlike, and to do this Mr. Stroh had brought electricity into requisition. Figs. 5 and 6 show respectively a perspective view and details of the apparatus. On a board, A, is a vibrating iron armature, B, vibrating about 70 times per second. Electro-magnets C C and C^1 C^1 maintain the vibrations. Contact springs D and D^1 are used to close alternately two circuits while B is vibrating. E is the battery. One electro-magnet and one spring, however, are found to be sufficient to maintain the vibrations. A contact key, F, is convenient to start and stop the vibrations, the handle of which can be held by X. The rods G G^1 communicate with air pumps H and H^1. H is made of two hollow blocks of wood, the cavity being divided by a thin leather diaphragm clamped between the two halves of box I. Discs of cardboard, K, strengthen the diaphragm. Two air channels, L and M, communicate with the two parts of I, and end at L^1 M^1, where the connecting tubes can be fixed. H^1 has only one communication, the end being fixed on a brass lever, P (Fig. 5), so that it can be attract each other. An illustration of the attraction by either pole is shown by means of a disc (Fig. 10), when either of the drums attracts the disc presented to it. The tube E' (Fig. 2) may be replaced by a straight tube, E'' (Fig. 11), with drum M'. If the drum Q be presented to M, the latter places itself opposite, as shown in Fig. 11, when the membranes are vibrating in the same phase, and towards the side when vibrating in opposite phase.

Another experiment required the arrangement of apparatus as in Fig. 12. Here the balance of Fig. 7 is replaced by a little board, S, with two brass uprights, T T', supporting brass tubes U and U'. The outer ends of U and U' are connected to R and S, the inner ends carrying two drums, Y and Z, whose axis is in the same straight line. U and U' are held by friction, so that they can be easily moved as required. If between Y and Z a cork ball be lightly suspended, it will be attracted and repelled in certain directions. Fig. 13 shows the drums. If the ball be at 1, 2, or 3, and able to move in the direction C D, and the membranes vibrate in the same or opposite phase, the ball is equally attracted towards each membrane; but if the ball be so placed as to be free to move in direction A B, it is attracted, in the case of opposite phase, to the central position. In the case of similar phase it is attracted to 3 or 3', and repelled from 1.

(TO BE CONTINUED.)

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OVERHEAD TELEPHONE WIRES.

The threatening attitude lately assumed by the authorities of New York and of several large cities of the Continent of Europe towards overhead wires is at length causing a flutter of excitement among the telephonic interests of this country. After deliberately disregarding every warning, and steadily closing their eyes to the inevitable, they are beginning to apprehend what may be the consequences of their recklessness. One of the signs of this awakening is to be found in Colonel Webber's recent paper on telephonic communication, read before the Society of Arts, a paper which would have been excellent had it been opportune. Two or three years ago it might have been of some use; to-day it is of very little. The plea in answer to all his warnings will be the expense of paying any heed to them.

This is the plea now being set up in New York, even by those who are disinterestedly opposed to a further multiplication of overhead wires. The cost of transferring them to underground channels would, it is urged, be enormous; and the corporations cannot reasonably demand such a sacrifice, even in the interest of the public. Powerful influence is being brought to bear upon the commission of inquiry in New York, and we believe that the magic name of Jay Gould is thrown into the scale against the compulsory removal of what Colonel Webber rightly described as both a growing danger and a nuisance. Of course an attempt is made to throw technical dust in the commissioners' eyes; the electrical feasibility of carrying the wires underground is questioned; and as it is always easy to find plenty of people to testify to their own non-belief, the well-founded convictions of the few experts who really know what they are talking about will, it may be feared, be over-ruled. Among the witnesses called we notice the name of Mr. David Brooks, of Philadelphia. The system of underground insulation of which that gentleman is the inventor is alone a sufficient proof of feasibility. It has been well tested, and is undoubtedly a good system—as good a system, certainly, as any yet devised for overhead wires, where insulation is never perfect, and never can be. That other systems of underground insulation are not only feasible but well established is evidenced by the vast army of wires laid below the streets by the old telegraph companies, and enormously increased by the Post Office during the past ten or twelve years. One of the witnesses before the New York Commission is reported to have stated that he "understood that all underground systems had been discarded in London." A visitor to London, after an absence of three or four years, might be excused for thinking so; he might have gone further and "understood" that all overhead wires were particularly admired in London, especially if they crossed the public squares and swept the main thoroughfares at sufficiently absurd angles. But the exact contrary is the fact. So far from the telegraph wires having been taken up, those that remained overhead have in recent years, for the most part, been buried. The wires that disfigure and endanger the most architecturally beautiful and most crowded of our metropolitan avenues are telephone wires, or wires more or less related to telephonic enterprise, and they have all been erected within a comparatively recent date. They grow and multiply both in numbers and in impudence. Nothing is sacred where they can or dare make a lodgment. They fasten on our churches, they perch on our palaces, and, as if to purposely affront and alarm us, they bisect the view of every public building with lines of the thickest and span the longest that human perversity can devise. All this and more is being done by the parties responsible for telephonic extension; and now that the inevitable outcry is being raised against their wanton disregard of public safety and good taste we are asked to "consider the expense" of drawing back. It seems to us that this was a consideration for themselves long ago; they had due warning, and the very data on which they based their prospects of prosperity must have shown that to make the business profitable it must become offensive and dangerous if conducted on the lines originally contemplated. On the whole, nobody is responsible but the companies themselves.

We say that they, and they alone, are responsible, notwithstanding the excuses, economical and technical, continually put forward by their apologists. Colonel Webber, for example, attributes the circumstance of overhead wires, which ought, he considers, to be "objects of interest if not of admiration," becoming "objects of dislike to all, and animosity to many," to the unreasonableness of the public in refusing way-leaves—that is to say, the companies have had to resort to tortuous, ugly, and unsafe routes, because householders would not give the asked-for facilities. But the public will know how to answer this charge. Colonel Webber's ideal system seems to consist in the substitution of light wires of short length for the existing long and heavy wires—"miniature" lines, in fact, almost invisible, and, where visible, ornamental. To say nothing of the questionable economy and security of such a scheme, it is one which has certainly never been submitted to the refractory householder, and therefore he cannot be blamed for preventing its adoption. Light lines would, no doubt, be harmless, but in rough weather they would probably be disabled, otherwise they would have come into general use before now.

There is, we repeat, no middle alternative between over-

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head wires and underground wires; and, stripped of all pretences, the one sole reason for persevering with the overhead system is the cost of making a change. But, costly or not, it will have to be made, and the sooner it is begun the less expensive will it be. We cannot tell what may be the aims and hopes of the few financial giants who in a very literal sense seem to be the wire-pullers of telegraphic and telephonic enterprise in the States; but of this country it is safe to say that the time must come, and is not far distant, when a peremptory stop will be put to what is nothing less than a public scandal; and that neither from the State nor from local Corporations can the offenders expect any pecuniary assistance to get them out of their difficulty.

FIRE RISKS AND ELECTRIC LIGHTING.

If anything were wanting to emphasize the great advances that have been made by electric lighting recently, it might be found, we think, in the interest which is being taken in the question of the risks run by those who use this system of illumination. These risks are of two kinds—from fire and from electric shocks, which may be fatal to human life, the latter, however, only occurring with certain systems. Both are preventible, if but ordinary caution and care be used in fixing wires and in handling both them and the various machines. We are at present most concerned with the first of these two risks. Several accidents from fire having already occurred through the use of electric lighting plant, and these accidents having in some cases resulted in damage to property, it was but natural that the insurance companies should begin to make inquiries into the why and wherefore of these accidents, and also as to the means for their prevention. The result has been that both in America and here fire insurance companies have consulted together, and, with the advice of competent electricians, have drawn up certain rules as to the placing of dynamo machines, size of conductors, and other minutiæ connected with the supply of the electric light, which they think should be complied with in order to render such supply safe. These rules, we may remark, have long ago been regularly adopted by the leading electric light engineers, who are as much aware of their necessity as the insurance companies.

To draw up rules is one thing, to see them properly carried out, another affair altogether, particularly when dealing with such an agency as electricity. For the insurance companies to send round their inspectors to report upon the safety of an electric light system when these inspectors know little or nothing about electric lighting, either generally or specially, is manifestly absurd. This fact has been recognised by some of the chief fire insurance companies, and they have, taking time by the forelock, determined to give their inspectors the opportunity of learning something about electric lighting generally. To this end, arrangements have been made with Mr. Day, of King's College, by which he will give a course of lectures on the "Fire Risks of Electric Lighting" for the benefit of the inspectors of fire insurance companies. These lectures will deal with the subject in a practical manner, and are intended to convey to those attending them a practical knowledge of the subject, so that, while attending to their employers' interests, they may not, through ignorance, impose unnecessary restrictions on the introduction of electricity, either for lighting purposes or power distribution. The first of these lectures was given on Wednesday evening last. The action of the fire insurance companies in this matter cannot be too highly commended, and is likely to be productive of great good in the future. We have not space to refer at greater length to this question now, and, indeed, our reference to it hitherto has been but scanty, for the simple reason that it has been crowded out of our pages by matter which could not be postponed. We have, however, resolved to do justice both to this and to other subjects, which we have hitherto, greatly against our inclinations, been compelled to somewhat neglect, by adding another eight pages to *The Electrician*, beginning with the new volume. We hope that by this means we shall be enabled to deal with all branches of electrical science in their turn, at all events for the present.

MR. CHARLES HOCKIN, C.E.

In our last issue we briefly informed our readers of the death of Mr. Charles Hockin, C.E. His death occurred so suddenly that we had little more than time to express our extreme regret at the occurrence. We are now able to give a somewhat fuller, though necessarily inadequate, account of the man who, without hesitation, we venture to class as one of the most, if not *the* most, brilliant ornament of that branch of civil engineering which is chiefly concerned with telegraphy. We use the word "inadequate" advisedly, since no amount of writing alone could describe the loss that has been sustained in the removal of Charles Hockin. Though never to be found in the ranks of those who strive after the "bubble reputation" by bringing themselves and their inventions obtrusively before the public at every opportunity, and, without any attempt to invent, patent, or lecture, we have no hesitation in saying that Mr. Hockin did more good to the profession of telegraphic engineering than all the patentees, inventors, and lecturers grouped together. As a first item in his character, let us state that he was in thought, word, and deed essentially the very acme of honour and honesty. Secondly, in spite of a nervous and retiring disposition, he was boldness itself when the time came to speak out fearlessly at a board meeting, on important subjects, when commercial men were listening for his decision, and when others had hesitated to speak.

Amongst his professional brethren he was a universal favourite, both on account of his sterling personal qualities, as well as his thorough knowledge of his profession. There was nothing with which he did not seem to be well acquainted, from matters of the smallest importance to those of the highest, and yet his modesty was always conspicuous.

Having now given our frank and honest opinion of the character of the comrade whose loss has left a blank in the list of those who belong to the profession of telegraphic engineering, we will give all that we can glean of the most distinguished man we know of in the profession to which he had attached himself.

Of the details of his very early life we know nothing, nor is it important that we should, since it is quite clear that his early education (on which character and morality in after life so much depend) left him a thorough English gentleman.

Reverting, now, to his career, as far as we can trace it. Charles Hockin, leaving Aldenham School, entered St. John's College, Cambridge, in October, 1859, was a scholar in May of the same year, and graduated as third wrangler in 1863. He was afterwards elected to a fellowship. Soon after, having a decided *penchant* for practical electricity, he joined, as an assistant, the firm of Forde and Fleeming Jenkin, in the Adelphi, although he had at the time ample means of his own. Whilst with this firm he worked with Mathieson on the question of the reproduction of electrical standards by chemical means (*vide*, *Report* of British Association for 1864), and he also played a very important part in the Committee on the British Association Unit, of which Committee Professor Maxwell (now deceased) and Sir William Thomson were members. Mr. Hockin joined the firm of Messrs. Clark, Forde, and Taylor in 1872. As a member of that firm he was engaged at sea for months and indeed years as their representative in the work of inspecting and

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superintending the laying of all those numerous cables projected and contracted for by the Telegraph Construction and Maintenance Company. Whilst engaged in this work Mr. Hockin visited Australia, India, China, &c., returning *vid* San Francisco and the United States, thus making the tour of the world. He was constantly making improvements in methods of testing and also using the formulas of Messrs. Longridge and Brooks, and working, as it were, backwards, he determined the co-efficient of friction for various types of submarine cables. One of his latest works published was a method of finding the positions of *two* faults in a submarine cable, a problem before considered impracticable. It is published in the *Journal of the Society of Telegraph Engineers*, and is a very high-class mathematical paper. Unlike those who know so little that they are afraid of imparting it to others, he was never tired of explaining abstruse points to his friends, even when their knowledge was far below his standard.

We have already noticed his wonderful knowledge, but before closing this brief article we must add that his acquaintance with the science of nautical astronomy, &c., caused his words to be respected by even the most scientific officers in the surveying department of the Royal Navy, whilst the officers of large merchant ships often condescended to consult Charles Hockin on their own calculations.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot agree with Mr. Johnstone that "the rushing together of the scattered invisible electricity to form the visible body called a spark is a demonstration that electricity is a *peculiar kind of matter;*" or that "the rushing together of the invisible electricity can arise from no other cause than that of attraction *within* its own particles." If the rushing together of the invisible electricity depends upon an attraction existent within its own particles, it could not leave the sphere or be projected from it in any direction; its tendency, if any, would surely be to the centre of the sphere.

Again, it must be obvious that the uninsulated conductor plays a most important part in the phenomenon, for the particles all tend towards that conductor, and it is impossible that such a result could take place if the rushing together of the electricity depended upon the attraction *within* its own particles.

The explanation I give as to the cause of the phenomenon is as under:—

Every form of matter, whatever its condition, has a certain capacity for the forces of gravitation, magnetism, electricity, heat, &c., and it is the object of my letters in *The Electrician* to prove that all these manifestations of force are only different phenomena resulting from the action of one force, which force comes to the earth from the sun in the form of light.

An insulated sphere and the matter immediately surrounding it—invisible though that matter be—is capable of being *temporarily* surcharged with this force *at the expense of the force in the contiguous matter*—for, of course, Mr. Johnstone will admit the impossibility of creating force, and, therefore, it must come from somewhere. This surcharge is gradually removed if the sphere be left to itself—it disappears rapidly in a moist atmosphere, from a well-known physical cause; and it is instantaneously drawn away if an uninsulated conductor be brought near, owing to the contiguous matter exerting its influence through the *conductor* to restore that equilibrium which had been temporarily destroyed. The spark is due to the friction to which the particles of matter are exposed during their aggregation and combination.

Mr. Johnstone will perceive that the questions he propounds are incapable of being proved in a few lines, as they are inseparably connected with fundamental principles of the most abstruse character. Mr. Johnstone will therefore excuse my declining to enter upon the consideration of the subject in future, except in continuation of the course of papers which, for some weeks past, I have been contributing to *The Electrician*.—Yours, &c., RICHARD C. SHETTLE, M.D.

Reading, April 25, 1882.

POSTAL TELEGRAPH DEPARTMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the correspondence now going on in your columns, it may interest some of your readers to know that there are many clerks in the engineering branch of the Postal Telegraph Service throughout the country who were taken from the instrument room on account of their familiarity with the technological part of their profession, and who are now in a worse position than they would have occupied had they not left the commercial branch. These clerks were induced to leave the instrument room on the understanding that in the engineering branch, where the duties are much more varied, and where a certain amount of technical knowledge is an absolute requirement, much larger emoluments would be obtained. What is the result of such loud talking? I could point to cases where men have spent much time and money in obtaining this much-talked-of "technical knowledge," who are to-day in a worse position than those who have less service, and who are in many instances as atomatous as the instruments they work.

Not very long ago one of the best appointments in the service was advertised as vacant in the official circular, and the usual notice asking surveyors to state what knowledge of telegraphy the applicants possessed was duly appended. The vacancy was filled up in course of time, and to show what the "knowledge of telegraphy" is worth in such cases, it will hardly surprise your readers to learn that the fortunate individual, after he had been at work for some time, made a proposal to join up a single needle in circuit with double current apparatus! "Technical knowledge" is simply a trump card which the Department declares will win, but when the game comes to be played the trump is generally changed.—Yours, &c., JEHU.

ELECTRIC LIGHT COMPANIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the prospectus now being circulated by the Gülcher Electric Light and Power Company (Limited) my directors observe that great use is made of the working of the Anglo-American Brush Electric Light Corporation (Limited), the profits made and the results obtained by that company being described in a way intended apparently to lead to the inference that similar results will be obtained by the Gülcher Electric Light and Power Company (Limited).

I am, therefore, instructed to point out that the prices obtained for licenses, or by the sale of patents, or the profits of working by the Brush Corporation are no criterion of the prices that will necessarily be obtained for the licenses or patents or working of any other company; and, indeed, the very fact of so many countries, districts, and counties having been thus covered by one substantial and successful company rather tends to detract from the benefits that are likely to be derived in the future by other companies.

My directors would not, however, have thought it right to take any public notice of this Gülcher prospectus if it had not been for the way in which the report on the subject of the lighting at South Kensington Museum—the publication of which was authorised by the Lords' Committee of Council for Education—has been employed, without specifying that it relates to the Brush system only.—Yours, &c.,

WILLIAM J. CORDNER, Secretary,
Anglo-American Brush Electric Light Corporation.

Belvedere-road, Lambeth, London, May 2, 1882.

TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In "Slip" of your issue of the 15th ult. you mention that telephonic communication has been effected in

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America between two places distant from each other 130 miles.

This has been equalled lately in Egypt, we having effected communication by telephone between the offices of Alexandria and Cairo of this Company, the distance being 136 miles.

Excepting a little disturbance now and then from induction, owing to these lines being carried on the same poles for 100 miles as the Suez-Alexandria lines, we find no difficulty whatever in speaking, the different voices being easily distinguished.—Yours, &c., W. GILLESPY,

Superintendent Eastern Telegraph Company.

Cairo, April 22, 1882.

THE RECENT AURORA CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since sending you what information I possessed regarding the aurora disturbances which occurred about the 17th and 20th ult., and which was published in last week's *Electrician*, I have received and enclose some fresh data.—Yours, &c., H. SAUNDERS.

May 3, 1882.

New Zealand-Sydney cable. Sydney reports:—Nine a.m., 17th, current equal to ten cells, but did not interrupt working.

Melbourne-Tasmania section. Tasmania reports:—Very strong alternate currents interrupted work all through the 17th. Brilliant aurora visible at times. The Victorian-New South Wales and South Australian land lines also interrupted during magnetic storm. Another aurora on the 20th. Strong currents, but were able to work. Magnetic disturbance general throughout Australian colonies on above dates.

Following from Melbourne Observatory:—Great disturbances on the sun's surface on the 15th, and from the 17th to the 20th, magnets violently disturbed; bright aurora generally visible on those dates; quieted down on the 21st.

ON THE THEORY OF THE CARBON TELEPHONE.

By W. F. BARRETT, Professor of Physics in the Royal College of Science, Dublin.

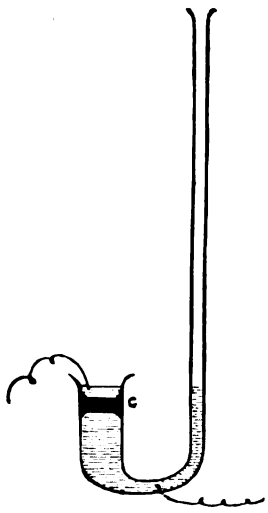
[The following Note was read before the Royal Dublin Society, on February 17th, 1879, and though indicated in the *Proceedings* of that Society, and in the *Telegraphic Journal* for February, 1879, has not hitherto been published.]

Having received, through Mr. Edison's kindness, several buttons of compressed lampblack, such as he uses for his carbon telephone and micro-tasimeter, I was anxious to ascertain whether the diminished electric resistance that is produced by pressure was due to any internal change in the substance of the button, or merely to the greater intimacy of contact of the electrodes with the surface of the carbon, which latter would naturally result from the increased pressure.

My first experiment was made to ascertain the extreme range of resistance to which a carbon button is susceptible under varying pressure. For this purpose I fixed underneath the specific gravity pan of a delicate balance a smooth disc of metal; below this, upon an adjustible metal support with a smooth flat top, I placed the carbon button. The electric circuit was made through the metal support on one side, and through the balance on the other. Having equipoised the specific gravity pan, a weight of one milligram was put into it; this caused the disc beneath it to rest lightly on the carbon button, whereby the circuit was completed and the resistance of the button thereupon determined. Additional weights were now placed on the sp. gr. pan, and the resistance found in each case. The result of these experiments showed that, starting from a pressure of 1 milligram, and going up to 500 grams, the resistance of the button could be made to vary from 5,000 ohms to 2 ohms. The higher figure depends entirely on the smoothness, horizontality, and proper superposition of the electrodes, and hence can only be taken as meaning a very high and variable resistance.

In order to determine whether the increasing weight simply increased the number of points of contact with the electrodes, I made the following experiment:—A glass tube was drawn out and bent into the shape shown in the figure, a platinum wire being sealed into the bend. A carbon button, C, was then firmly cemented into the wide part of the tube, a little mercury poured over it, and also into the narrow tube, till the mercury was the same on both sides. By this means the carbon was held between liquid electrodes, almost without pressure; its resistance was then determined. Pouring mercury into the narrow tube the pressure could be increased, the intimacy of contact remaining practically unchanged throughout. In this way it was found that the resistance when the mercury was nearly level was 3 ohms, with a pressure of 2 centims. of mercury the resistance was 2 ohms, and remained practically at this figure, varying scarcely a tenth of an ohm up to the highest pressure that was tried, from 20 to 30 centims. The difference of an ohm at the commencement was, doubtless, caused by the extrusion of a small air-bubble, which had lodged below the carbon.

Thus it will be seen that when intimate contact is secured at the beginning, increase of pressure makes no change in the resistance. Hence the electrical behaviour of the carbon telephone is indentical with that of the microphone, only in the one case we have a larger number of minute points of contact than in the other. When sonorous vibrations are communicated to the electrodes between which the button is held, the current passes more or less freely as more or less points of carbon touch the vibrating electrode. If, instead of carbon, spongy platinum be taken, the same action would occur, and such a material I find forms a fair telephone transmitter. In fact, electrically speaking, we cannot anywhere draw a line of demarcation between such an arrangement and the transmitter employed by Reiss



The objection to the Reiss transmitter is the extremely small number of points of contact that are brought into play. Nevertheless, as Reiss himself showed, if the contact between the platinum stud and button of his transmitter be carefully adjusted, speech can be transmitted by his transmitter and heard in his receiver. Feebly, it is true, for if the transmitter be spoken to loudly the circuit will be rapidly and completely interrupted and restored, so that a chattering will be heard in the receiver.*

It is, I believe, generally acknowledged that the effect of pressure on the conductivity of bodies was first noticed, or thought worthy of notice, by Count du Moncel. Afterwards, in 1864, Professor Zetzsche and M. Clérac employed powdered graphite, more or less compressed in glass tubes, as rheostats on telegraphic lines. The following quotation is from the first volume of Du Moncel's "Exposé des Applications de l'Electricité," published in 1856:—

"Une chose assez curieuse, et qui paraît être au premier abord en contradiction avec la théorie que l'on s'est faite de l'électricité, c'est que la plus au moins grande pression exercée entre les pièces de contact des interrupteurs influe considérablement sur l'intensité du courant qui les traverse. Cela tient souvent à ce que les métaux de l'interrupteur ne

* Using a carbon telephone or a microphone transmitter with the latest form of receiver that Reiss adopted (an electro-magnet on a sound-board, with its armature fastened at one end), I find that every syllable is perfectly heard when the sounding-board is pressed to the ear. In fact, except in point of convenience, there is very little to choose between such a receiver and the ordinary Bell telephone.

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sont pas toujours dans un etat parfait de décapage au point de contact, mais peut-être aussi à une cause physique encore mal appréciće."—P. 246. Afterwards, in a paper published in the *Comptes Rendus* of the Paris Academy on December 2, 1872, the Count stated "that the resistance of dry powdered wood charcoal, or of powdered retort carbon, varies according to the degree of closeness (tassement) between the electrodes."

P.S.—Since writing the above paper I read in the *Telegraphic Journal* for February 15, 1879, a letter from Count du Moncel, who writes as follows:—

"Like Professor Barrett, I concluded that the effects determined by the pressure proceeded from a more intimate contact of the molecules of the bodies at the point of contact. The following is what I said, in fact, in the *Comptes Rendus* for July 6, 1874:—'It is always the case that the conductivity is in ratio to the degree of pressure of the plates of communication. This last action evidently depends on the greater or less intimacy of contact which is produced at the time between the two superposed surfaces. For in substituting a drop of distilled water instead of the pressure, we immediately obtain, with the plate simply placed upon the table, the maximum of deviation just as if these plates had been pressed by presses.'"

ELECTRIC LIGHTING BY INCANDESCENCE.

BY J. H. SWAN.

I trust that I may be pardoned if, in the short lecture which I have undertaken to give on the principles of electric lighting, I assume that you are unacquainted with even the elementary principles of the subject. I am conscious that probably there are many here of whom this unflattering assumption is not consonant with fact. But I think it far preferable that these—a minority, I am convinced—should be condemned to listen to a twice-told tale rather than that the larger proportion should be enduring the severer punishment of hearing words the meaning of which they do not understand. I therefore propose to speak as though the principles of electric lighting were entirely new to you.

With few exceptions, electrical phenomena do not present themselves to common observation, but one of these exceptions so strikingly illustrates the power of electricity to develop *light* as to constitute the most natural introduction to my subject. I refer to the phenomenon of lightning.

We have all of us seen a thunderstorm. We have all watched the sky grow dark on a summer noon, and seen how from the "high-engendered battle" of the clouds, the fiery spears leapt out and stabbed the earth, and we have all either seen or heard how, if by chance a tree was struck, it was set on fire, and when a glowing shaft fell on a lightning-rod how it was gathered within the cold embrace of the metal, and passed quietly through it to the earth.

There is, of course, the widest conceivable difference between the scathing, erratic, evanescent lightning-flash and these constant orbs of light which fill this room with their soft splendour; and yet they are both forms of electric light. The *agency*, the *acting cause*, which produces these diverse effects, is *one* and the *same*—it is *electricity*. In one case, where it bursts all bounds and rushes with flash and detonation from sky to earth, it is electricity in a state of enormously high tension. In the other, it quietly traverses these wires through all their various turnings, without once offering to leave the metal track, it is electricity in a state of *low* tension. The difference is enormous, but it is a difference of *degree* only, not of *kind*. It is the difference of a grain and many tons. The *tension* or *potential* subsisting between a thundercloud and the earth is so great that, as you know, the electric discharge will often strike from the one to the other through a mile of air while if those wires which have a certain difference of potential, as I shall show (like the cloud and the earth in kind, but many million times less in degree), are brought within a hair's breadth of each other no discharge will occur.

[It was here shown that the thickness of a piece of note paper, which was held nipped between the terminals of a powerful battery, was sufficient to prevent a discharge taking place between them.]

Those wires are in communication with an electricity-producing apparatus of considerable power. That you may not run away with the idea that, because I can bring them so closely together, as I have done, without any discharge taking place from one to the other, therefore they are powerless, I will make them just touch, and then withdraw them a little from each other. You now see that a stream of fire follows in the line of separation. The potential or tendency to discharge was not sufficient to *initiate* a discharge through a stratum of cold air of the thickness of the paper, but when heat has once been developed by a large current passing at the points where the metals touch, and where, because the points of contact are few, *resistance* is offered, the heat so developed has the effect of producing vapour of so much *less resistance* than *cold air*, that, as you see, a strong flash follows the separation of the two plates.

It is to be remarked that the electric discharge from the thundercloud assumes the form of lightning *while passing through the air*, but disappears in the lightning conductor. Similarly the current, which produced the outburst of flame in passing from wire to wire through a highly-resisting medium of metallic vapour, passes quietly through the thick conducting wires without producing sensible heat in them.

There are some vats on the opposite of this building, in the exhibit of Messrs. Elkington, used to illustrate that wonderfully interesting process of electro-type and electro-plating and gilding, where, through the operation of the silent-working energy of electricity which the wires transmit, *solid metal* is separated from *watery solutions*, and deposits itself in layer on layer until, if need be, a thick crust of *copper*, or silver, or gold, or any other metal the baths may contain, is produced from them.

It is almost inconceivable that the agency which invisibly, without noise or motion, or sensible heat, follows the naked wires of the electro-type bath, and causes metal to be deposited on some intricate mould, with no more demonstration in its action than attends the slow-working force which causes the growth of a tree—it is, I say, almost inconceivable and incredible that this quiet and undemonstrative power is identical with the power which hurls the thunderbolt. Yet there is no doubt whatever about the fact. Franklin proved it. The proof was, perhaps, fresher in the *public* memory when I was a boy, than even now, in these more scientific days. As a boy, I very well remember hearing this rhyme:—

> With a spark that he caught from the skies,
> He displayed an unparalleled wonder,
> And saw with delight and surprise
> That a rod can protect us from thunder.

The particular point which I wish to bring out is the very one emphasised by the rhyme I have quoted,

> That a *rod* can protect us from thunder.

It marks the fact which lies at the foundation of electric lighting—that electricity passes quietly and harmlessly and without sensible effect through a thick rod or wire of metal, while in passing through air or some other bad conductor its track is marked by the development of heat and light. This is one of the most remarkable properties of electricity—that it is carried or *conducted* with great facility by some substances, such as metals, and with great difficulty by other substances, such as glass or wood or air. Hence metals are called *conductors*, and the other substances I have mentioned are called non-conductors; but it is an inexact division, because there is no such thing as a conductor which does not offer some degree of resistance, however slight, to the passage of electricity, and there is no non-conductor which does not conduct electricity to some minute extent. Even among the metals which are called conductors the difference in the facility of conduction is great. Copper is one of the best conducting metals, that is to say it is one of the metals which offer least resistance to electrical transmission; and that is the reason why copper is used to form the wires which conduct the electric current to electric lamps.

But *why* is it that, while the electric discharge traverses the air, fire is produced, and when it enters a mass of *metal*, the fire is quenched? It is for the simple reason that the air offers a high degree of resistance to the passage of electricity, and the metal offers comparatively a very low resistance. It always happens that, when by dint of high tension or high electromotive force (equivalent in mechanical action to high pressure), a strong electrical current is driven through some small mass of matter offering a high resistance to its passage, heat and light are produced. It is a universal law, both of mind and matter, that *friction produces heat*, and the case with which I am dealing is an example of that general law, inasmuch as the conversion of electricity into heat when it encounters resistance involves an action analogous to friction. All electric lighting depends on the heat-producing effect of this species of electric friction, consequent upon a strong current forcing its way through a high resistance. The resisting medium may either be a gas, like atmospheric air, as in the case of lightning, or as in this case.

[A flashing discharge was here produced by means of an induction coil.]

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The tension of the electricity here is a thousand times greater than in the case of the first experiment.

The resisting medium, which serves to produce light, by being heated electrically, may, as I have said, be either a gas or vapour, or it may be a solid substance—a piece of carbon for example—or even a *metal*; for if a very strong current be forced through a thin metallic wire it will become glowing hot.

[A great length of platinum wire was here heated to a white heat.]

Here we have a large quantity of electricity concentrated in a conductor of small mass. The wire offers a high resistance because of its thinness. A lightning-flash, you will remember, while harmless to the thick metal rod of the lightning conductor, will melt bell wires. The resistance which a wire offers to the transmission of an electric current depends not only upon the *kind* of *metal* of which it is formed, but upon its length and thinness. Its resistance is great in proportion to its thinness and length. The amount of heat produced in a given wire depends on the amount of its resistance and the amount of current passing through it in a given time.

I will show that different kinds of metal differ in their conductivity, or rather differ in the degree of their resistance—one kind of metal resisting the passage of an electric current more than another.

Here is a wire chain, made in alternate sections of platinum and silver. The wire is quite uniform in size throughout, and yet, if I pass a current through it, although the current will be equally distributed through its entire length, the platinum sections will become much more heated than the silver sections, for the reason that platinum offers six times as much resistance to the passage of electricity as silver, and, consequently, six times as much heat is developed in the platinum wire as in the silver wire. The temperature of the platinum is increased even much more than six times that of the silver, because of its less capacity for heat.

The same quantity of current which passes through the platinum sections has necessarily to pass through the silver sections. Just as when water is travelling in a pipe, partly choked at one part and clear at another, exactly the same quantity of water passes in a given time through the choked part of the pipe, and through the clear part, so it is here—through every section of the circuit the same current passes in the same time, and yet as you see, with what widely different effect.

[A wire in alternate sections of platinum and silver was here heated by the current, the platinum sections alone becoming incandescent.]

The meaning of these experiments is this—that every substance, even *metals*, such as platinum, or even *silver* and *copper*, the best conducting substances known, *impede* or *resist* in some degree the transmission of electricity, and in resisting, become heated.

Whenever an electric discharge takes place, or whenever an electric current is transmitted, no matter of what power the electric discharge may be, and no matter what the size or kind of the material through which the discharge or current passes, *heat* is developed in proportion to the *strength of the current and the degree of the resistance offered to its passage*. If the current is strong, and the resistance high, a great amount of heat is developed, and if this great amount of heat is developed in a small mass of matter, then the small but highly resisting mass so carrying the strong current becomes *intensely hot*. *Electric light is, therefore, the concentrated heat product of electric energy expended in overcoming resistance.*

These principles are applied to the practical purpose of producing artificial light in two different ways, both amply illustrated by the lamps which, through the enterprise of Major Page, are distributed in such variety and numbers throughout this building, once more worthily devoted, like its parent of '51, to the "fruitful strife" of scientific and industrial competition.

There are in this exhibition a great number of electric lamps. There are the lamps of Siemens, Brush, Crompton, Brockie, Hawkes, Weston, Gravier, Joel, Pilsen, Jablochkoff, Edison, Lane-Fox, Maxim, and there are my own lamps. Now, happily for me, bound as I am to "turn the accomplishment of many years into an hour-glass," all these lamps of various name are resolvable into simply two classes, namely, arc lamps and incandescent lamps. I will illustrate by experiment the principle of these two different types of lamp.

[An open arc was here shown and explained; also an enlarged image of the arc, and pencils of an arc lamp.]

When electric light is produced in this manner, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electromotive force, and a strong current are necessary, in fact, such electromotive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of maintaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed) put a stop to reduction at a point at which much too large a light is produced for common purposes.

Now we come to incandescent lamps. This type of lamp has infinitely more general interest attaching to it than the other, inasmuch as it is adapted to domestic lighting. On this principle of construction it is possible to produce an exceedingly small light without having to expend any more power upon it, in proportion to light, than would be necessary in producing a much greater light. This function of divisibility is a most important accompaniment of electric lighting by incandescence, and at once gives to electric lighting the power of universal applicability. I will not discuss the history of the development of this extremely simple and practical method of producing light electrically, nor the merits of different lamps. Naturally I should not be regarded as a perfectly impartial witness, and the exhibition itself is sufficient to inform you on that point. I shall, therefore, treat the subject in a purely abstract manner.

[The principle of electric lighting by incandescence was perfectly illustrated by the white-hot platinum wire.]

In the incandescent lamp the light-giving body is a *continuous solid conductor*. It must be very thin, a bad conductor, and capable of bearing an enormous temperature. In the arc type of lamp, of which I have spoken, there is a break in the continuity of the solid material at the point where light is produced. There is a gap between the two thick pencils of carbon, and while the light is produced between them this space is bridged over by a stream of intensely hot vapour. In the incandescence type of lamp there is no such gap in the circuit where light is produced, but a continuous filament, which is made white hot.

An incandescent lamp in its simplest form is a *vacuous glass bulb pierced by two wires supporting a filament of carbon*. The filament must be very thin and uniform, and it must also be well connected with the wires. The vacuum must be almost perfect. If these conditions be fulfilled, the lamp will be durable, even when heated to a high degree of incandescence.

(TO BE CONTINUED.)

THE ELECTRIC LIGHTING BILL.

The following notice has been issued by the Board of Trade in connection with the above Bill:—

Board of Trade, April 29, 1882.

The select committee appointed to consider the subject of electric lighting have expressed a desire that the following suggestions should be made for the guidance of the parties interested:—

The number of parties interested in the Bills with which the committee has to deal is large, and to hear all these parties separately would be impossible in point of time, and would involve great and unnecessary expense to the parties. The committee propose, therefore, to do as was done in the case of the Tramways Bill of 1870, viz., to call upon the several interests concerned in the general measure to arrange for appearing each by one set of counsel, agent, or witnesses. It has been the object of the Board of Trade in setting the Government Bill to frame a complete scheme applicable to all cases, and thus to preclude the necessity for proceeding with any private Bills on the subject of electric lighting. The committee have now decided that they will first of all hear the parties on the several points of general principle raised by the Government Bill, and will endeavour to settle the large questions which arise between the different classes of interests concerned.

These interests may be classified as follows:—1. Electric lighting companies. 2. Municipal corporations and local boards who now supply gas within their own boroughs and districts. 3. Municipal corporations and local boards who now supply gas both within their own boroughs and districts and also within other districts. 4. Municipal corporations and local boards whose districts are supplied with gas by gas companies. 5. Municipal corporations and local boards whose districts are supplied with gas by other municipal corporations. 6. Road authorities. 7. Water, gas, and other companies whose works may be interfered with. 8. Private persons, traders, and others who are to be supplied with electric light or power.

There appears to be no reason why each of these interests should not be represented by one counsel, agent, or even by one witness, or set of witnesses only, as was done in the case of the Tramways Bill of 1870.

The Board of Trade, at the request of the Committee, therefore desire to invite the promoters of and petitioners against the various schemes before the Committee to consult together for the purpose of grouping themselves, and selecting persons to represent the respective interests before the Committee. If, after these interests are dealt with, there are special cases requiring to be dealt with separately, the Committee would be prepared to hear the parties interested in these cases separately on the special points which concern them. (Signed) HENRY G. CALCRAFT.

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INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).

The fifteenth ordinary general meeting of the members of this Company was held at the City Terminus Hotel, on the 29th ult, under the presidency of Colonel James Holland.

The managing director (Mr. W. Andrews) having read the notice convening the meeting, the common seal of the Company was fixed to the register of proprietors, and the report of the directors was afterwards taken as read. An abstract has appeared in *The Electrician*.

The CHAIRMAN: I shall have to advert to the report in my remarks, which I hope will be very brief, because fortunately for you and us we are able to present a satisfactory statement of accounts for last year. Last year was by no means a bad one. We declared then practically an 8 per cent. dividend, and carried £7,500 to reserve. This year, although we have had various difficulties to contend with which we had not in the preceding year, we are able to recommend the same dividend, and to carry a somewhat larger sum to the reserve—namely, £8,000, thus, by the accretion of interest and so forth, increasing our reserve fund from £18,730, which it stood at last year, to £27,436 in the present year. With reference to the accounts generally, there is very little that need be entered into, unless any gentleman requires any special explanation, which I shall be happy to give; but I may say, as to the main point, that the expenditure, although slightly increased, is more than balanced by the increase in the receipts. I may add, further, that as far as we know we have not a single bad debt. Just before the meeting the directors were assembled together to look over the accounts up to the last moment, and I find that the only outstanding accounts are one from the Secretary of State for India, which, I presume, we may consider good, and another, for £2 10s., from a highly respectable party, so I think we are tolerably safe in that respect. With regard to the Company's claim against the Russian Government for damage done to our wire during the war with Turkey, that remains very much in the same state that it has been in now for some years, but we have ascertained that our receiving any portion or the whole of the claim depends on the outcome of the claims of Russia against Turkey. A great deal of diplomatic action is now being carried on with respect to those claims. Should Russia be able to obtain her demands from Turkey, we may come in, I hope, for a fair portion of ours. At any rate, the subject shall not lose our best attention. We have, among other matters of interest, announced to you that Messrs. Siemens Brothers have given notice to terminate, on the 31st of July next, the contract between them and the Company for the maintenance of the Company's lines. This was a matter provided for by our articles of association, that after a period of twelve years and a half, on giving a certain notice, either party were at liberty to determine the contract for maintenance. Messrs. Siemens gave the notice, at the same time intimating that they were perfectly willing to carry on the maintenance for the future on somewhat altered conditions. We have had a considerable amount of correspondence on the subject, and, as is very often the case in matters of that kind, we differed in opinion as to what they should ask, and we as to what we should give. The fact is that in the result we felt ourselves very much in the position that the celebrated Mr. Canning was in when he was discussing commercial affairs with the Dutch Government. Many may remember a cipher despatch which he sent to the Minister of the Hague, in which these lines were found:

> "In commercial transactions, the fault of the Dutch
> Is giving too little and asking too much."

[laughter]. That was the opinion we came to, and I have no doubt that Messrs. Siemens, on their side, felt very much the truth of the same adage. At any rate, we could not in justice, as we conceived, to your interests come to an arrangement with them, and the result is that we take the maintenance over in our hands. I may say that the directors, one and all, feel no doubt whatever in their own minds that that will be satisfactory in the result to the pecuniary interests of the shareholders. At the same time that I make this statement, I wish to say that we trust that every kind of amicable feeling may continue between us and those most distinguished scientific persons, Messrs. Siemens, whose name is known throughout the whole civilised world for their science and enterprise. Among other matters, we advert here to the interruption of our cables during the past year, and we state that for a considerable time the whole business of the country was carried on on one of our two wires, irrespective of the other wire, which was interrupted, and of the other two wires of the Eastern Company, showing that the facilities for communication with the East are very much greater than the necessities of the case, for actually there are four wires devoted entirely to Indian correspondence. All of those wires connect on one side with innumerable subordinate wires from all parts of the western world, and on the other side with many wires connected with China and trans-Indian provinces. The whole of the business was satisfactorily carried on on that one wire. To show you that it was carried on satisfactorily, I may state that the average time in conveying messages from London to Calcutta was not more than an hour and a half, and I think you will allow that the merchants will be, as I have no doubt they are, perfectly satisfied with that fact; and I think it speaks somewhat for the able management of this Company, especially under the able executive control of my friend Mr. Andrews, to whom the greatest part of the credit is due. The cause of all these numerous wires, these great facilities, is not far to seek. No doubt there is a very keen and active rivalry between us and the Eastern Company, and again between both of us and the Great Northern Company, as far as China and trans-Indian countries are concerned. We all do our best to catch the British merchant, and when we have got him we do the best we can to keep him; and we have found that the best way of keeping him when we have got him is to give him all the facilities in our power, and to be satisfied with such a moderate profit as may satisfy you for the risk you have in holding our stock. I may mention that, since the word-message was introduced, the messages have become shorter and shorter, most probably by the improvements made, day by day almost, in codifying the messages, so that few words express a great many ideas. Although this takes away from our profits in one direction, yet merchants, finding the great facility with which they can express their desires in three or four words, use those three or four words more frequently than the longer messages, so it is as broad as it is long—in fact we find that, although the increase in our profits has not been very great, owing to the shortness of the messages, they have increased steadily, and we feel very little doubt that by continuing that policy of giving facilities to merchants our business will steadily increase, and with profitable results. We advert also to a matter that has given us a great deal of trouble during the past year, the interruption, owing to fractures, of our cable between this country and Germany. Telegraph cables are frequently breaking in many parts of the world, but with our line—the line we rent from the Post Office (it is a line of no great length) across the North Sea—there have been several, and very vexatious, breakages through carelessness or wanton mischief by fishing boats' anchors on the spot carelessly damaging our cables, and interfering with those engaged in repairing them, their nets covering places where the cable lies. This annoyance we found is impossible to get rid of without the intervention of the Government. Governments are always slow to move, but our Government has at last taken up the matter, and are in communication with the various Continental Governments for some measure whereby injuries of this kind may be put a stop to. We owe a debt of gratitude to the Press—especially to *The Times*, but to the Press generally—for the active way in which they took up the cause of the companies, and not only of the companies, but also of the merchants of England, for our only cause of existence is the welfare of the mercantile community. A very great debt of gratitude is also due to the well-known chairman of the Eastern Company (Mr. Pender, M.P.), whose energetic action in the matter has had a great effect in stimulating the Government to action. We now hope that this cause of annoyance and interference with our profits, though not thoroughly removed, will be considerably modified in future. Nothing else occurs to me to mention on the report, except to reiterate what we express here, as to the loss of our valued colleague, Mr. Barlow, who, on account of his numerous increasing professional engagements, has felt compelled to resign his seat. In a very kind letter to his brother directors he has offered his valuable technical aid on any occasion we communicate with him. We have done our best to supply that loss by appointing on the board till it came to his turn to resign, when his appointment will be in your hands, Mr. Earle, a gentlemen well known in the telegraphic world, and highly esteemed. We have also, I may say, appointed our friend Mr. Weaver as official director, an appointment which Mr. Barlow held. There is no man in England better known, I believe, and more appreciated as a practical telegraphist than Mr. Weaver, and I am quite sure I need not wait for your expression of opinion to the effect that you are well satisfied with that choice. I now propose the following resolution—"That the report and statement of accounts be received and adopted." I shall ask Mr. Tritton to second that, but before putting it to the meeting I shall be very glad to hear if any gentleman wishes to make any remark on the report.

Mr. J. HERBERT TRITTON having formally seconded the motion,

The CHAIRMAN: After a pause, and no one rising to address the meeting, put the motion in the usual manner, and it was carried. Continuing, he said: I have now to propose "That a dividend be, and is hereby declared for the half year, ended December 31, 1881, of 17s. 6d. a share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 10s. a share, both free of income-tax."

Major-General G. B. TREMENHEERE, R.E., seconded the motion, which was carried.

The CHAIRMAN: It now becomes my duty to vacate the chair, as I go out by rotation. I shall ask Mr. Tritton, the deputy chairman for the meeting, to be good enough to occupy my place.

Mr. TRITTON, having taken the chair, said: I have to state to the meeting that, in accordance with the articles of association, the following directors retire by rotation, Colonel Holland and Mr. H. H. Meier. They are both eligible for re-election, and offer themselves accordingly. It is a very great pleasure to me to move the re-election of our good friend, Colonel Holland, in the first place. No man has done more for the prosperity of the Company during the time he has occupied the chair than Colonel Holland. His energy and his assiduity in that office have been very great indeed, and it gives me great pleasure to move that he be re-elected. With regard, also, to Mr. Meier, of Bremen, he was one of the original directors of the Company, and a gentleman to whom we owe a considerable debt of gratitude. He is, as I dare say is known in this room, a gentleman holding a very leading position in the important town of Bremen, and also a *persona gratissima* in high quarters in his own country.

Mr. H. WEAVER seconded the re-election of the gentlemen named, and both were declared re-elected, on which Col. Holland resumed the chair.

The CHAIRMAN: Mr. Tritton and gentlemen, I return you my best thanks for the compliment you have paid me—both for the kind terms in which Mr. Tritton has proposed my own re-election and that of our friend Mr. Meier, and to you for the cordial manner in which you have accepted the proposal. I can only say that as long as I have the power to be of any use to the Company it will be my earnest desire that I should serve you. The only business remaining now is to state that Messrs. Kemp, Ford, and Co., the Company's auditors retire, and being eligible, they offer themselves for re-election. I shall be glad if some gentleman will propose their re-election.

The Hon. ROBERT GRIMSTON accordingly moved, and Major WOOD seconded the re-election of Messrs. Kemp, Ford, and Co., and the motion having been carried,

The CHAIRMAN formally intimated that that closed the business of the meeting, and thanked those present for their attendance.

Mr. FORD: As I hurried to attend this meeting, fearing you might not constitute a quorum, I put to myself this question, Is there any pleasure without an alloy? and I was able to answer it affirmatively—if I could have attended the meeting of this Company on any day but Saturday at twelve o'clock. But I do assure you that the pleasure I have of attending this meeting is greatly alloyed by the fact that it has been to me a disturbance of those family relations which most men who are actively engaged in business make of that day. I hope, after this expression of my feelings and my experience, you will be able to give all the pleasure without the alloy for the future, and that you will appoint another day than Saturday for our meetings. I beg to move a vote of thanks to the chairman and directors.

Mr. K. ANDERSON seconded the motion, and it was carried.

The CHAIRMAN: I should like to say one word. I have to thank you first of all on behalf of my colleagues and myself for your vote of thanks,

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which is our greatest reward. I wish to explain, for the benefit of Mr. Ford and the other gentlemen present, that it was a very unpleasant necessity that compelled us to fix on this day (Saturday) as the day of meeting. We could only get our accounts passed up by a certain date in the course of this month. We are bound by our articles of association to issue our report fourteen days before the meeting, and it brought matters so close, these two days being united. Remember, also, that we are bound to hold our meeting before the end of April, so we were absolutely in this corner, that unless we met on Saturday or Sunday, which I suppose Mr. Ford would still more strongly object to, we should have had no meeting at all. I trust that that awkwardness will not occur again.

The proceedings then terminated.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

Report of the directors to the seventeenth half-yearly general meeting, 12th May, 1822.

The revenue for the half year ended December 31, 1881, amounted to £86,692 18s. 0d.; the working expenses to £12,467 12s. 11d., leaving a balance of £74,225 5s. 1d.; to this is added £4,510 17s. 6d., brought forward from June 30, 1881, making a total of £78,736 2s. 7d. After deducting income-tax, £1,025 10s. 6d., there remains a balance of £77,710 12s. 1d. First and second interim dividends amounting to £39,000 have been distributed, leaving the sum of £38,710 12s. 1d. to be carried forward. Since the 31st December last a further sum of £39,635 14s. 4d. has been invested on account of the reserve fund. It was found necessary to remove a fault which appeared in the shore end of the cable at Pernambuco. The repair was successfully effected by the Telegraph Construction and Maintenance Company's steamer "Kangaroo" with only a slight delay to the traffic. The electrical tests of this section show that the entire deep-sea portion is absolutely perfect, and as good in insulation as when first laid. The Company's cables continue in good working order. The directors regret to announce the resignation of Mr. de Andrade Pinto from the pressure of other engagements. The vacancy will be filled up by the appointment of a representative in Brazil, in accordance with Article 27 of Concession.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices May 3.		Business Done Week Ending May 3. Highest.		Lowest	
Anglo-American	54¼,	54¾	54½		54	
Do. Preferred	85,	86	85½		85	
Do. Deferred	24½,	25	25		24½	
Brazil Submarine	11,	11¼	11¼		11	
Cuba	8¼,	9	8¾		8¾	
Do. Preference	15½,	16½	—		—	
Direct Spanish	5½,	5¾	6¼		5¼	
Do. Preference	14½,	15½	—		—	
Direct United States Cable	11¼,	11¾	11 15-16		11¼	
Eastern Telegraph	10¼,	10¾	10 5-16		10¼	
Do. 6 per Cent. Preference	12¼,	13	13		12¾	
Do. 5 per Cent. Debentures, 1899	102,	107	—		—	
Eastern Extension	11¼,	11¾	11¾		11 9-16	
German Union	9¼,	10¼	10¼		9¾	
Globe Telegraph and Trust Company.	6¼,	6¾	6¾		6¼	
Do. Preference	12½,	12¾	12¾		12¼	
Great Northern	12½,	13	13 1-16		12 15-16	
Indo-European	30,	31	—		—	
Mediterranean Extension	2,	2¼	—		—	
Do. Preference	8¼,	9	9		8 11-16	
Reuter's	13,	13¼	13¼		13¼	
Submarine	260,	270	—		—	
West India and Panama	1¾,	2	2		1 15-16	
Do. 1st Preference	8¼,	9	8 11-16		8 11-16	
Western Brazilian	8,	8¼	8¼		8 1-16	
West. Union 7 per Cent. 1st Mortgage	121,	126	—		—	
Do. 6 per Cent. Sterling Bonds	102,	105	105		105	

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1 11-16	1 9-16
Oriental	¼,	½	7-16	½
United Telephone	13¼,	13½	13 11-16	13¼

ELECTRIC LIGHT.

Eastern Electric Light and Power	¾,	1	—	—
Electric Light and Power	¾,	1	1	¾
Anglo-American Brush	13¼,	13¾	13¾	12½

TRAFFIC RECEIPTS FOR APRIL, 1882.

Companies.	April, 1882.	April, 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,600	3,193	607	—
Direct Spanish Telegraph Company	1,824	1,337	487	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	29,269	26,746	2,523	—
Eastern Telegraph Company	42,667	45,289	—	2,622
Great Northern Telegraph Company	17,640	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

Another Electric Tramway at Berlin.—A second electric tramway, constructed by Messrs. Siemens Brothers, was opened on Saturday, the 26th April. The new tramway runs from Charlottenburg to the Spandauer Bock, in the western outskirts of Berlin.

ADDRESSES.

M. THEILER & SONS, Manufacturing Electricians,
86, CANONBURY ROAD, LONDON, N. Factory: 1, Alwyne-lane, N.
Specialities—Morse Instruments, Type Printers, Cable Relays and Keys, Duplex, Quadruplex, & Translating Apparatus, P.O. Pattern. MAGNETO BELLS and SWITCH BOARDS of superior construction. Gold Medal, Melbourne, 1880; Silver Medal, Paris, 1881.

TAYLOR and Co., Mica Merchants, 90, HATTON GARDEN, LONDON.

RANSOMES, HEAD, & JEFFERIES, Orwell Works,
IPSWICH. London Office: No. 9, GRACECHURCH-STREET, E.C.
Specialities—Portable, Vertical, and Stationary Engines, fitted with patent governors, as used in the electric lighting on the Thames Embankment, London, &c.

EDWARD PATERSON, Electrical and Telegraph
Engineer, 76, LITTLE BRITAIN, LONDON, E.C., and European Telegraph Works, POWNALL-ROAD, DALSTON.
Telephones and Transmitters, and all Fittings for Central Exchange Systems and Private Lines. Ayrton and Perry's Instruments for Electric Light Measurements. Electric Lighting Apparatus, Cables, &c. House and Mine Signals.

PHILLIPS BROS., Electricians and Electrical Wire
Manufacturers, MACINTOSH-LANE, HOMERTON, LONDON.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c.

MARSHALL, SONS, and Co., Limited, Britannia
Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

BRITISH ELECTRIC LIGHT COMPANY (Limited),
HEDDON-STREET, REGENT-STREET, LONDON, W.
Gold Medal at the Paris Electrical Exhibition, 1881.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

HOOPER'S TELEGRAPH and INDIA RUBBER
WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

JULIUS SAX, 108, GREAT RUSSELL STREET,
BLOOMSBURY, LONDON. Works: MORWELL STREET, BEDFORD SQUARE.
Electric Bells, Fire and Thief Alarms, Water Gauges, Watchmen' Clocks, Telephones and Transmitters. Lines Erected and Maintained. Lightning Conductors. Electric Light Apparatus supplied and fixed. Prize Medal, London, 1862; First Prize, Sydney, 1879; Prize Medal, Melbourne 1880; Prize Medal, Paris, 1881.

W. T. GLOVER and Co., Insulated Wire Manu-
facturers, 25, BOOTH-STREET, MANCHESTER. Works: Salford.
Specialities—Specially covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron Wire for Aerial Lines. Fancy covered Copper Wire (Paraffined) for Telephonic and Bell purposes. Cotton covered G.P. Wire for Bell Work. Special Makes of Electric Light Leads for the Brush, Gramme, &c., systems.
All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

BARRAUD and LUNDS, 41, Cornhill, London, E.C.
Inventors, Patentees, and Manufacturers of Synchronised Clocks, Time Balls, Flashing Signals, and all the Apparatus connected with the Determination, Distribution, and Control of Time Signals.

THE LONDON ELECTRIC WIRE COMPANY,
WENLOCK BUILDINGS, IRONMONGER ROW, OLD STREET LONDON, E.C.
Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

J. STIFF and SONS, LAMBETH, LONDON.
Manufacturers of Porous Cells, Cylinders, Plates, Telegraph Insulators, Battery Jars, Chemical Apparatus, &c., in Vitrified Stoneware, Plumbago Crucibles.
Prize Medal for above Paris Electrical Exhibition, 1881.

DOULTON & CO., Lambeth Pottery, LONDON, S.E.;
100, SOHO STREET, LIVERPOOL; GRANVILLE STREET, BIRMINGHAM; and 6, Rue de Paradis Poissonnière, PARIS.
Manufacturers of Insulators. Porous Cells, Battery Jars, Preservation Pipes for Underground Cables, Crucibles, Chemical Apparatus, Acid Bottles, &c., &c.

NEWTON'S PATENT LAW and PRACTICE,
Price 2s. 6d.
This standard work contains all legal and other information necessary for intending patentees, including Government charges, agency fees, and rules of the Commissioners of Patents.
TRUBNER and Co., Ludgate-hill, and may be obtained at the Office for Patents, 66, Chancery-lane, W.C.

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The List of Applications will be Closed on or before Wednesday, the 10th May, 1882.

THE INDIAN AND ORIENTAL ELECTRICAL STORAGE AND WORKS COMPANY LIMITED.

CAPITAL £400,000 in 80,000 SHARES of £5 each.

First Issue £200,000 in 40,000 shares of £5 each, of which 10,000 shares are reserved for future payment to the vendors, at the option of the Company. Amount payable on application, £1; amount payable on allotment, £1; and the balance by calls as required, but the first call will not be made within six months.

DIRECTORS.

ERNEST NOEL, Esq., M.P., 29A, Grosvenor-square, W., Chairman. Chairman of the Eastern Electric Light and Power Company Limited.

The Right Hon. the Earl of Crawford and Balcarres, 47, Brook-street, W., Chairman of the "Brush" Electric Light and Power Company of Scotland Limited.

Alexander McArthur, Esq., M.P. (Messrs. W. and A. McArthur), Silk-street, E.C.

Major Charles H. Strutt (now in India), Managing Director of the Eastern Electric Light and Power Company Limited.

J. S. Trotter, Esq., 2, Walton-street, S.W.

*W. M. Bullivant, Esq. (Messrs. Bullivant and Co.), 72, Mark-lane, E.C., Director of the Anglo-American Brush Electric Light Corporation Limited.

*Colonel F. G. Steuart, 14, St. James's-square, S.W., Director of the Hammond Electric Light and Power Supply Company Limited.

* These gentlemen being Directors of the Electrical Power Storage Company Limited (the vendors) it is intended that they shall not join the Board until after the allotment.

BANKERS.

Messrs. Brown, Janson, and Co., 62, King William-street, E.C.

SOLICITORS.

Messrs. Trinders and Curtis Hayward, 14, St. Helen's-place, E.C.

CONSULTING ELECTRICIAN AND ENGINEER.

Latimer Clark, Esq., M.I.C.E., 6, Westminster Chambers, W.

BROKERS.

Messrs. Foster and Braithwaite, 27, Austinfriars, E.C.

AUDITORS.

Messrs. Deloitte, Dever, Griffiths, and Co., chartered accountants.

SECRETARY.

H. Cleland Heywood.

OFFICES.

Winchester House, Old Broad-street, London, E.C.

PROSPECTUS.

This Company is formed for the purpose of introducing into the East the latest discoveries made in the scientific world, more especially those regarding the storage and utilisation of electricity.

With this view the Company has first acquired from the Electrical Power Storage Company Limited, their patents or rights for India, Ceylon, the Straits Settlements, Egypt, and Malta, and in the secondary batteries, the inventions of Messrs. Sellon, Swan, and Volckmar, together with all improvements they may make from time to time.

The system of electric lighting which has succeeded best in England has already been introduced into India, Egypt, and Malta, with rapidity and success, by the Eastern Electric Light and Power Company, and its operations are being further extended into the Straits Settlements and Ceylon, where negotiations for large and important contracts are now pending. The shares of the Eastern Company, on which £3 have been paid, are now quoted at £4, or a premium of over 30 per cent.

It is now generally conceded that there exists in the East an almost illimitable scope for lighting under the incandescent system, and further that, alike on the grounds of security and economy, the use of what is known as secondary batteries is indispensable to the attainment of perfection in that class of lighting; for, while incandescent lighting is capable unaided of competing successfully with other modes of illumination, it at once assumes a position of far more assured ascendancy when it is combined with the use of storage batteries, preventing alike all possibility of mishap or risk of waste in the supply of the light-producing power.

The dynamo electric machines of C. F. Brush and other inventors are now in operation in all quarters of the globe. In an exhaustive experiment made with a "Brush" dynamo electric machine no less than 35 of the 2,000 candle-power arc lamps were maintained in perfect efficiency on a circuit of 20 miles, the conductor employed being the ordinary small cable used by machines supplying only one or two lamps on a circuit. This experiment proved to demonstration the possibility of conveying power by an electric current with a small and inexpensive conductor over a distance previously supposed to be unattainable by such means, thus enabling advantage to be taken of the abundant supply of water and other motive power. The invention of the Sellon-Volckmar battery will now enable power to be forwarded to, and received at, great distances, and to be economically distributed in quantities of great or minute magnitude according to the exigencies of the occasion. The Directors have obtained independent reports from Mr. Cromwell F. Varley, F.R.S., and Messrs. Clark, Forde, and Co., in confirmation of the merits of the invention.

In electric lighting alone, therefore, large and lucrative employment is certain. It is believed, however, that there is a far wider field open for the employment of capital as regards the generation, storage, and distribution of electrical power. Throughout the vast area of territories in which this Company's operations will be extended scientific and engineering inventions are but in their infancy. Among the many densely populated cities of the East only one or two are provided with adequate means of locomotion, such as are afforded in European and American cities by local railways, tramways, public conveyances, &c., and any attempt at their introduction has met with signal success. Again, the establishment of the extensive new cotton mills in India points to the sure and rapid development of manufacturing energy in the East, bringing with it the need for engineering and mechanical appliances and machinery, in which electricity will daily assume a more prominent position.

In a speech made by Mr. J. S. Sellon (the Vice-Chairman of the Anglo-American Brush Electric Light Corporation, and one of the inventors of the Sellon-Volckmar battery), on the occasion of the first public demonstration of the battery at the Crystal Palace, he stated that, beyond a very small circle of friends, no mention had ever been made of what had been achieved—no public announcements or notices of any kind had ever been put forward—that the company, with a capital of £300,000 for the exploitation of these secondary batteries throughout the world, was formed, and the whole of the capital which had so far been offered for subscription had been taken amongst his own circle of private friends within a few hours, and would have been subscribed three or even 10 times over; in fact, his great difficulty had been in cutting down his friends' demands. This explains why public attention has not yet been more prominently called to the establishment and operations of the Electrical Power Storage Company.

The terms of purchase by this Company from the Electrical Power Storage Company Limited of all the patents and rights for India, Ceylon, the Straits Settlements, Egypt, and Malta (together with the license to manufacture, after a period of one year from this date, batteries in England for use in those countries) is the sum of £75,000, payable as to £25,000 in cash on the completion of the agreement, and as to £50,000 within a period of twelve months, either in cash or fully paid-up shares, at the option of the Directors. In the meantime, the Electrical Power Storage Company is bound to supply the orders of this Company at greatly reduced prices. A royalty per horse-power will also be paid on the cells purchased or manufactured by this Company, terminable, however, when the total royalties amount to £25,000. This Company is also entitled to purchase at a fixed proportionate amount all patents or improvements acquired by the Electrical Power Storage Company other than those above mentioned.

One of the conditions of the purchase is an indemnity against any claim for infringement of patents which may be made within a defined period.

No promotion money whatever, excepting customary brokerage, will be paid in respect of this Company.

A working agreement has been entered into with the Eastern Electric Light and Power Company Limited (which is hereafter referred to as the Eastern Company), by which, in consideration of this Company licensing the use by the Eastern Company within the territories embraced in the field of operation of this Company of all the batteries purchased from this Company or its assignees, and agreeing to allow to the Eastern Company the maximum discount on purchases, the Eastern Company reciprocally accords to this Company the license to use in all such territories the Brush dynamo machines, and agrees to allow to this Company its maximum discount. This arrangement secures in reality to each Company what is known in treaties as a "most favoured nation clause," and it is of special value to this Company because of the power which (as already explained) the Brush Machine has of conveying currents over great distances. As a further consideration for this agreement the Eastern Company guarantees the payment of the necessary preliminary expenses of this Company.

In estimating the profits to be made from a manufacture, the monopoly of which is secured by a patent, it is undesirable to enter into details of cost. It is intended without delay to construct electrical railways and tramways, and it is obvious that the profit to the Company must not be regarded as limited only to the sale or hire of secondary batteries for electric lighting or kindred purposes. The Eastern Company is prepared to give an order at once for batteries to store an equivalent of 3,000 horse-power.

It is not intended for the present to call up more than £2 per share, which, after payment of £25,000 to the vendors, would leave available for working capital a sum of £35,000. As the business of the company requires additional capital so further calls will be made.

The only agreements entered into are those referred to above, viz.:—

1. An agreement dated 4th May, 1882, between the Electrical Power Storage Company Limited, of the one part, and the Company of the other part.
2. An agreement, dated 4th May, 1882, between the Eastern Electric Light and Power Company Limited, of the one part, and the Company of the other part.

The agreements and the memorandum and articles of association of the Company may be seen at the office of the solicitors.

Where no allotment is made the deposit will be returned, and if a smaller number of shares be allotted than applied for the surplus of the deposit will be applicable to the payment of the amount due on allotment. If any instalment is not duly paid the allotment will be liable to be cancelled, and payments previously made to be forfeited.

Applications for shares must be made in the form accompanying the prospectus, and lodged, with the deposit of £1 per share, with the bankers 5th May, 1882.

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DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for April amounted to £1,824, against £1,337 in the same month of last year.

SOUTH AFRICAN TELEGRAPHS.—The receipts from telegraphs in Cape Colony in February last amounted to £4,736, against £4,282 in the same month of last year, or an increase of £454.

CANADIAN TELEGRAPHS.—News from Ottawa, dated 4th May, says that the Montreal Telegraph Company Amalgation Bill was read in the Senate a third time and passed on that date.

ROYAL INSTITUTION.—Mr. A. G. Vernon Harcourt, F.R.S., was announced to read a paper before this institution last night (Friday) on "The Relative Value of the Different Modes of Lighting."

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for April amounted to £17,640. From January 1 to April 30 they amounted to £71,280, against £71,156 in 1881, and £66,316 in 1880.

CABLES REPAIRED.—The Western and Brazilian Telegraph Company (Limited) notify that, with the repair of the northern section of their cables in Brazil, telegraphic communication is now re-established with Ceara, Maranham, and Para.

ELECTRIC LIGHT IN LIVERPOOL.—Trial has been made with the electric light as a means for illuminating the Brown Reading Room of the Liverpool Free Library. It is stated that the Town Council consider the result to be very satisfactory.

CHURCH STRUCK BY LIGHTNING.—A new Presbyterian church was struck by lightning last week, although protected by a conductor. It is even stated that the conductor was split in two. We should imagine that it must have been of faulty construction.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during April was 3,938, estimated to produce £3,800, against 3,058 messages, producing £3,193. The receipts for February, estimated at £3,200, realised £3,271.

ELECTRIC LIGHT AT WINDSOR CASTLE.—We understand that Mr. Crompton, in conjunction with the Electric Light and Power Generator Company, is engaged in the work of introducing the electric light into Windsor Castle. Maxim lamps and Bürgin machines are being used.

ASSOCIATION OF LOCAL BOARDS.—This association, which has been recently formed by the union of several local authorities in the Manchester district, has resolved to petition Parliament in favour of the Government Electric Lighting Bill, and against any alteration in its principles.

NEW ELECTRIC LIGHT COMPANY.—The Brush Midland Electric Light and Power Company is announced, with a capital of £250,000 in £5 shares. The company is a concessionaire of the Anglo-American Brush Company. The purchase money is £25,750 in cash, and £18,000 in fully paid shares.

THE GAS INTERESTS AND THE ELECTRIC LIGHTING BILLS.—It is stated that all the principal London gas companies have amalgamated their opposition and retained counsel to watch over their combined interests as one body. A similar arrangement has also been made between the provincial gas companies who are likely to be affected by the Bills now before Parliament. It is hoped that the Select Committee will be able to report before Whitsuntide.

AIDS TO SCIENCE.—The French Association for the Advancement of Science have made the following grants for the year 1882, viz.:—To M. Brillouin 1,000 francs, to continue his studies on electric currents; to M. Debrun 200 francs, to continue his studies on electricity; to M. Gaston Tissandier 800 francs, to continue his studies on heavy electric motors.

WEST INDIES.—At a recent meeting of the Court of Policy of British Guiana, a petition was presented by the West Indian and Panama Telegraph Company praying for an extension of the term of their present subsidy for twelve months. The application was favourably received, and it was decided that the item should be placed on the forthcoming estimates.

ELECTRIC LIGHT AT EASTBOURNE.—The Local Board of Eastbourne have decided to accept the offer of the local electric light company to light the grand parade with sixteen Brush lamps of 2,000 nominal candle-power. The cost will be £27 10s. per lamp, which gives a total increase of £231 17s. on the expense of using the 90 gas lamps displaced, which have cost £368 3s.

CHINA.—The Great Northern Telegraph Company announce that a station has been opened at Nankin. Dating from the 1st May the uniform charge to the following stations—viz., Soochow, Chinkiang, Nankin, Chinkiangpoo, Chining, Lingching, Tientsin, and Taku, has been raised to 9s. 7d. per word. The rate for Shanghai, Amoy, and Hongkong remains as before, 8s. 4d. per word.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—An extraordinary general meeting of this society will be held on Thursday, the 18th inst., when, by special desire of the President and Council, Mr. Augustus Stroh, member, will repeat his interesting experiments in connection with attraction and repulsion due to sonorous vibrations, and will compare the phenomena with those of magnetism.

THE PATENT OFFICE.—A Parliamentary return just issued gives a classification of the whole receipts of the Patent Office for the financial year 1881-82, including stamps. From this it appears that of the total of £210,534, £111,060 was received in the initial stages, £29,520 of which being on petitions for letters patent, £21,500 on notices to proceed, £19,955 on warrants, £19,945 on letters patent, and £18,390 on final specifications.

EXHIBITION AT BRADFORD.—It is intended to hold a Fine Art and Industrial Exhibition at Bradford, on the 23rd of June next. It is also expected that their Royal Highnesses the Prince and Princess of Wales will be present at the opening ceremony. The Exhibition is to be lighted by both arc and incandescent lamps, and in order to obtain the necessary power the Executive Committee are erecting a galloway engine of 150 horse-power.

TENDERS FOR TELEGRAPH STORES.—The Great Eastern Railway are inviting tenders for the supply of telegraph wire for poles and general stores. Forms of tender can be had at the secretary's office, Liverpool-street, E.C. Patterns can be seen at the Stores, Stratford, between 10 a.m. and 4 p.m. from the 17th to the 25th inst. Tenders are to be sent to Mr. J. Hadfield, secretary, endorsed "Tender for Stores," by 10 a.m. on the 27th inst.

CHARING CROSS ELECTRIC RAILWAY.—The Bill which has for its object the construction of an electric railway from

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Charing Cross to the Waterloo Station of the London and South Western Railway came before Dr. Lyon Playfair, the chairman of Ways and Means, on Friday week. The railway is expected to be constructed in one year, although the promoters only limit themselves to have it completed in five years. The preamble of the Bill was proved.

Tenders Wanted for Electric Lighting.—The West Ham Local Board are inviting tenders for lighting by electric lights Stratford High-street, from the railway bridge to Maryland Point Bridge; Romford-road, from the Town Hall to Vicarage-lane; and Barking-road, from Trinity Church to the iron bridge. Further particulars can be obtained of Mr. Lewis Angell, C.E., engineer to the board, Town Hall, Stratford, E. Tenders, sealed and endorsed "Tender for Electric Lighting," are to be delivered at the office of Mr. Fred. E. Hilleary, clerk to the board, at the above-mentioned Town Hall, by 4 p.m. on the 13th June.

Electric Light in Bombay.—At a recent entertainment at "Durria Mehel," Malabar Hill, in honour of his Highness Maharajah Dhirag Mirza Maha Rao Shri Khengarjee of Kutch, the bungalow (the Palace by the Sea, as its name implies) and its extensive garden grounds were brilliantly illuminated. Three powerful electric lights (Brush system) were placed in a line from the porchway to the outer gateway, while two more lights were fixed at some distance on either side at right angles to the former, and one in the rear of the bungalow, the effect of the whole being a brilliant illumination of the place and its surroundings.—*Bombay Gazette.*

Death of Mr. Keates.—The death is announced of Mr. Thos. W. Keates, the consulting chemist to the Metropolitan Board of Works. He was born in 1817, at Poole, in Dorsetshire. His name will best be remembered by electricians, perhaps, in connection with the experiments conducted by him with the Jablochkoff system, and his report thereon. He was also one of the Crystal Palace Exhibition jury. In early life he was associated with Daguerre and others engaged in photographic work. Mr. Keates is acknowledged on all hands to have been most active and most able, and the Metropolitan Board of Works have lost in him a valuable servant.

Matching Colours by the Electric Light.—The *Warehousemen and Drapers' Trade Journal* says:—"The general employment of the electric light for indoor purposes is much to be desired on several accounts. It is a matter of common observation that colours cannot be properly selected by gas or candle light. Not merely do blues and greens get mixed up, but almost every tint and shade is altered by the yellow rays of our lamps and candles, and it is one of the great advantages of the electric light that it enables us to see colours as they really are. This alone would be enough to establish the superiority of the new lamps, but it is only the smallest of their advantages."

Means for Quick Exit From Theatres.—A letter from Rome announces that a priest of Ravenna, named Ravaglia, has constructed an electrical apparatus, which can be set in operation by simply pressing a button, and by which the doors of a large building can be instantaneously opened. The apparatus was tried during the last week of April at the Alighieri Theatre, in Ravenna, with the most satisfactory result. All the nine doors opened simultaneously, as if through some spiritual agency. The inventor hopes to improve his apparatus, so that, should a fire break out on the stage of a theatre, the rise in temperature would itself set the machinery in motion.—*The Times.*

New Company.—The prospectus of the London and Provincial Electric Lighting and Power Generating Company (Limited) has been issued. It states that the company has been formed to acquire the patent rights of the Chertemps Arc Lamp for the United Kingdom and British Isles, and for the use of the Gramme-dynamo machine and the British incandescent lamp throughout Great Britain and Ireland. The company proposes to supply lighting and motive power to its customers either by sale or hire, and to grant licenses and concessions. The capital is £250,000 in £5 shares. The vendor takes 8,000 shares in part payment of the purchase money, the remainder of which, £30,000, is to be paid in cash.

A Bold Assertion.—The President of the Midland Association of Gas Managers, Mr. R. O. Paterson, of Cheltenham, in addressing the annual meeting of this association a few days since at Birmingham, made the following statement:—"The action of the insurance companies in relation to the Exhibition at the Crystal Palace seems to point to a very alarming risk and danger. It may be a bold assertion to make, but I utter it with unfeigned belief, that in five years time (if not sooner) we shall have the last of electric lighting for many a long year to come. We wish it, nevertheless, no evil." We venture to think that before five, nay, before three years are out, Mr. Paterson will see cause to change his "unfeigned belief" as above expressed. Time will show.

Magnetical Observatories.—Her Majesty's Government have at last resolved to co-operate with the other nations in establishing a chain of circumpolar magnetical and meteorological observatories. The locality selected for a British station is Fort Rae, in the North of Canada, and the general superintendence of the work will be entrusted to a Committee of the Royal Society, the Royal Geographical Society being asked to co-operate as far as regards the promotion of their special studies. The *personnel* of the Expedition has not yet been selected. The Swedes have chosen Wyde Bay, in West Spitzbergen, for the site of their station, which will be manned by thirteen attendants, and is established at the cost of Mr. L. O. Smith, a merchant, who has placed £3,333, or 60,000 crowns, at the disposal of the Academy of Science for this purpose.

Phosphor Bronze for Telephone Wires.—According to M. Bede, a phosphor bronze wire, one kilometre long and two millimetres in diameter, has a resistance of 28 ohms., while an iron wire of the same length and diameter has a a resistance of 40 ohms. A wire which is well hardened at the drawing plate has a tensile strength of 120 kilogrammes per square millimetre, and stretches only about 1 per cent. before breaking. A wire which is properly annealed stretches about 60 per cent., but the tensile strength is only about 40 kilogrammetres per square millimetre. According to the same authority, a phosphor bronze wire when it breaks springs back to the neighbouring supports before the respective ends have time to do any injury, so great is its elasticity. In Belgium phosphor bronze wires of 8-10ths millimetre in diameter are largely used for telephonic work and found durable.

Electric Light at Derby.—At a *conversazione* given by the Derby Chamber of Commerce recently, in the St. James's Hall, Derby, the hall was partly lighted by incandescent lights, the necessary lamps and apparatus having been lent by Messrs. Davis and Sons, of the All Saints' Works, Derby. In order to contrast gas and electricity as illuminators, the electric lamps were placed in six groups down one side of the hall, whilst on the other side was a

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series of gas lights. The superiority of the new electric light was thus rendered obvious. Messrs. Davis also exhibited a pair of telephones, by which visitors were enabled to communicate with a local newspaper office; an "electro-dynamic motor," for driving sewing machines and other light domestic work; a lightning-conductor, with Captain Bucknill's galvanometer for testing the efficiency of these conductors; a number of electric bells, time-checking apparatus, &c.

Aurora.—M. Marino Poirier writes to *La Lumière Electrique*, under date Tarrara, 18th April, as follows:—"I send you some results of experiments made on temporary currents, due, I presume, to the aurora borealis. These currents began to be noticeable on the night of the 16-17th April. Towards midnight they had attained an intensity of + 25 degrees, measured on a telegraphic galvanometer having a resistance of 25 units. This intensity only lasted five minutes. From 4:30 a.m. to 5 a.m. the intensity remained stationary at from + 28 degrees to + 32 degrees, and then fell rapidly to + 10 degrees soon after touching −15 degrees, when the currents disappeared. At 7 a.m., 9 a.m., and 2:30 and 6 p.m. they reappeared for five minutes each time, rapidly attained + 25 degrees and fell to − 12 degrees. I made these experiments on a line 30 kilometres long, running from S.E. to N.W. The telegraph office is 460 kilometres from Paris, at an elevation of 400 metres."

The Electric Light in Calcutta.—An Indian journal says:—"We are informed that the greatest display of electric lighting that has as yet been witnessed in India will take place on the occasion of the marriage ceremony of Mr. Kayne Lall Seal's son, when about a whole mile of Calcutta streets will be lit up from April 15 to April 22 (especially on the last two days) by the Indian Electric Light Company (Limited) by means of three different systems of electric lighting—viz., forty Jablochkoff lamps of an intensity of about 500 candles each; five new Gramme differential lamps of an intensity of about 2,000 candles each; and four large Serrin lamps each of the intensity of about 5,000 candles each; the total intensity thus will be equal to between 50,000 to 60,000 candles. This display will enable the public to judge of the adaptability of the electric light for street lighting. It is also intended to have, for the Jablochkoff lights, alternate pink, yellow, and white globes, to see which is the most suitable colour."

Underground Wires in America.—A New York correspondent writes to us as follows:—"Underground lines are being laid between Jersey City and Newark. It is expected that nine and a half miles will be completed by the first of next month. The tests are very satisfactory, thirty conductors in an inch and a quarter diameter pipe give an average insulation of forty megohms per mile. The conductors are 18 gauge copper. The pipe is joined up in three thousand feet lengths. A tank large enough to hold six thousand feet of cable is placed at the juncture of two of these lengths. Half of the length of cable is pulled by a capstan in one direction. The cable is then cut, and the remaining half pulled in the other direction. By this method the cable is spliced only at intervals of three thousand feet, and a gang of men can easily lay a mile per day, or six thousand feet—something over a mile. The lines are being laid by Mr. David Brooks, of Philadelphia, whose system has already been tried in London, and found to answer well."

Carbons.—While many electricians are struggling with new dynamo machines, new lamps, and other parts of electric lighting plant, some few are quietly doing a good business in making the carbons for the lamps already in use. Much of the process by which these are made is kept secret. In America it is said that many of the best are made from the carbon obtained from petroleum refuse. M. Gaudoin is said to make them from wood sticks placed in plumbago retorts and slowly heated to drive off the volatile matter. The sticks are then soaked in acid solutions to remove impurities and the final desiccation then made in a very high temperature in a reducing atmosphere. The carbonised wood is then soaked in the carbides of hydrogen and the chlorides of carbon under pressure until their pores are completely filled with a homogeneous deposit of nearly pure carbon. The principal difficulty attending the manufacture of carbons from various materials is the purification of these, but with care finely pulverised retort carbon mixed with, perhaps, a little coal dust and tar may be employed with very good results.—*Engineer*.

On Radiated Light.—The following passage occurs in an article by Mr. N. H. Humphreys, communicated to our able, though antagonistic, contemporary, the *Journal of Gas Lighting*, on the subject of "The Theory of Radiated Light." Mr. Humphreys says:—"Granting that the photometrical value of a light is a component of two attributes, it is obvious that with any given standard, although the concrete result is the same, the attributes may be of widely different values. But they will always vary in inverse ratio; so that if the mean intensity is supposed to be increased fourfold, the area of the emitting surface will be diminished to a corresponding extent; and so in all proportions. Suppose an electric lamp of the incandescent kind, in which the light-emitting area may be 0·05 of a square inch, having a photometrical value equal to 16 candles; and a gas light of equal value, the emitting area of which is 4 square inches. The relative intensity of the former must be no less than $4 \div 0{\cdot}05 = 80$ times that of the latter. It is obvious that this is only a rough way of indicating the argument. To be accurate we must consider the value of the light. In the gas flame the *thickness* comes into consideration; and, since light is transparent, the whole of the light emitted is utilised in every direction—conditions which do not apply with the 'arc' light, nor with a solid light-emitting surface, such as the 'incandescent' light. It is a fact that any independent observer, looking at the various systems of public lighting at present in use, with a view of ascertaining the real respective values of the same—and ignoring his connection with gas undertakings, his share or rights in electric lighting concerns, or any other interested position in connection with the subject that may have fallen to his lot—will agree that a gas light is practically more effective than an electric light of equal photometrical value; that gas is better than electricity, light for light; and that a gas light, say of 1,000 candle-power, will be preferred by the public to an electric light of 1,000 candle-power. The considerations advanced in the previous paragraph may assist in comprehending the cause of this fact."

South Wales Institute of Engineers.—At a quarterly meeting of this institute, held at Cardiff recently, the paper read by Mr. Thomas Canning, of Newport, at a previous meeting, on "Colliery Explosions and Lightning," was discussed. Mr. Canning had stated his opinion that lightning was capable of causing these explosions, and that the explosion in the North Risca Colliery in July, 1880, had been caused by this agency. This view was disputed by several members.—Subsequently a discussion on the paper by Mr. William Thomas, F.G.S., of the Mardy Colliery, dealing with the question of "Electric Lighting for Collieries," ensued. The author supplemented his paper by further information as to the machine for producing the necessary power. In his paper he mentioned that the machine he had used for the

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production of the necessary power was the fan. In case anybody wished to try the experiment, he would like to say that they had abandoned that as a generator, and had now started a hauling engine, which, though smaller than the one originally used, they had found quite equal to the task of driving their machine.—Mr. J. Brogden asked Mr. Thomas why he used a Gramme machine in preference to others? The question for colliery managers, he said, was not so much the production of large lighting power as the necessity of transferring it to different portions of the pit.—Mr. Galloway said that the system adopted by Mr. Thomas gave a much greater amount of light for the same expenditure of power than the system of incandescent lamps such as those with which the room was then lighted. He did not remember the exact figures, but he imagined that a regulator giving a light of 2,000 candles required $2\frac{1}{2}$ h.-p., whereas incandescent lamps requiring the same power gave only one-fourth or one-fifth of that light, or about 450 candles.—Mr. T. H. Riches said that the difficulty was to estimate the intensity of the electric light; the makers themselves did not appear to be quite accurate in the matter. He had found, after careful investigation, that seven Maxim lights absorbed as much power as a 2,000 candle light, and a 2,000 candle light absorbed about two indicated horse-power. The question of the cost of the light depended upon the intensity of the light.—The President said it was not so much a question of the maximum of light as a question of distribution, and he believed the incandescent light had rapidly come into greater favour, as it did away with the unmanageable mass of light given by the arc.

The Edison Light in New York.—The following particulars with reference to the Edison system, so far as the work of erecting the necessary plant is concerned, will be of interest to our readers. The district is nearly a square mile in extent, being bordered on the east by the East River, on the south by Wall-street, on the west by Nassau-street, and on the north by Spruce-street, Ferry-street, and Peck Slip. The central station is situate at Nos. 255 and 257, Pearl-street. For the present only one of these buildings, No. 257, is being fully equipped. The work of putting in the boilers, boiler fittings, two smoke stacks, each 5ft. diameter and 80ft. high, with pumping apparatus, &c., is all finished, and the hoists and ventilating apparatus alone remain to be put in. The station equipment consists of six engines, six dynamos, and the resistance and regulators. The engines have been built by the Southwark Foundry and Machine Company, of Philadelphia. They each have a normal capacity of 200 h-p., making a total maximum capacity of 1,200 horse-power. The six dynamos are being built by the Edison Machine Works, Goerck-street, New York City, and are approaching completion. The weight of each dynamo is thirty tons, making the aggregate weight of the six dynamos 180 tons. The weight of the entire structure and electrical apparatus at No. 257, Pearl-street alone will be about 500,000lb., or about 250 short tons, and this weight will be distributed so as to average only 200lb. per square foot of structure. The boilers in this building, when under full headway, will consume 1,680 tons of coal and 4,200,000 gallons of water per annum, or a daily consumption of about five tons of coal and 11,500 gallons of water. Prior to March 1, 1882, 39,403ft. of the underground mains had been laid. In March 15,898ft. more were laid. The average feet laid per day during the month were 588, the average for the days on which actual work took place being 795, the least amount laid in one day being 423, and the largest, 1,246. There yet remains to be laid something over 18,000ft. of mains, besides bridges and connections at street intersections. The wiring of the houses was finished early in February, 946 places being wired altogether. The number of lamps thus wired is 7,916 A (16 candle) and 6,395 B (8 candle), or a total of 14,311 lamps. The lamps themselves are in store ready for use. Little, therefore, remains to be done but to finish laying the underground conductors before the first district to be lighted by the Edison system will be completed.

Another Electric Tramway in Berlin.—The following interesting account of the opening of the second electric tramway constructed in the city of Berlin has been transmitted to a daily contemporary.—"On Saturday (April 29) the trial trip was made with Dr. Werner Siemens's improved electrical apparatus and new carriages, on the tramway from Charlottenburg to the Spandauer Bock, in the western outskirts of Berlin. The electrician has in this line solved the problem of making the electric car overcome a rising gradient of 1 in 30. For half a mile the line has on leaving the suburb of Charlottenburg to ascend a hill, and here the speed was maintained at ten to twelve kilometres, or about seven miles an hour. Once on the top of the Spandauer Berg the line is on a level, and here the cars attained a speed of between sixteen and twenty kilometres, or an average of eleven miles an hour. The line, conducted as an ordinary tramway, is distinguished from any other by two thin wire cables, which you perceive at a certain elevation above it, resting on telegraph poles. On these two isolated cables, which are about nine inches apart, a tiny carriage runs, carried by eight wheels, those on the right being isolated from those on the left. A thin cable unites this miniature machine with the passenger car below, and the two wires it contains transmit electricity from the two cables above to the dynamo, which is fixed to the bottom of the car. On the top of the hill we pass a small house, where the steam engine is situated which generates the electromotive force. Your readers are aware that, in the first electric railway, produced by Dr. Werner Siemens at the Berlin Industrial Exhibition in the summer of the year 1879, the current was conveyed into the car by means of the rails and wheels, going from one rail into one set of wheels and out again on the opposite side from the wheels into the other rail. The same system is in use on the short line that connects the Royal School of Cadets at Lichterfelde with the railway terminus." The writer here enters into the reasons for discarding this method which have already been alluded to in our columns. Continuing, he says:—"Dr. Siemens's new invention of a small contact-car, running on two suspended cables and dragged along by the passenger car, to which it is attached, seems to be a decided improvement, and Berlin electricians assert that the problem of adapting electricity to tramways is now solved. The two cars employed to-day were not joined to each other, but each went separately. In future it is intended that two cars shall always leave the terminal stations at the same time, so as to meet halfway, where there is a siding. The stationary steam engine has to work at the rate of 36 horse-power, in order to produce the necessary force of about 6 horse-power for each of the two cars when on the level part, and of 10 horse-power when ascending the hill. I shall not enlarge on several experiments which were made to test the facility of driving the cars backwards and forwards and connecting the two cars, but limit myself to mentioning that, after lunch, the invited guests proceeded to Wilmersdorf to inspect an electric conveyance which runs on the high road without rails."

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THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

(CONCLUDED FROM PAGE 407.)

Thus far the results, Mr. Stroh was so modest as to say, did not go beyond those obtained in water by Dr. Bjerkness. But his, Mr. Stroh's, object had been not so much to repeat as to explain those results—to examine and ascertain exactly what it is that takes place in the air to cause action having such a singular identity with magnetism. Alternate compression and rarefaction of the air causing disturbance in the neighbourhood, or "field," would account for motion, though it does not explain direction. That this really happened was evidenced by enclosing a pair of

Fig. 14.

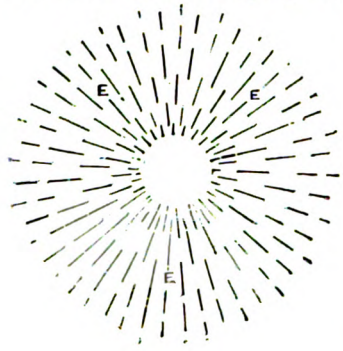

Fig. 18.

the vibrating diaphrams in an air chamber which communicated with a capillary glass tube containing coloured spirits of wine. When the vibrations were in the same phase the spirit fell, rising when the vibrations were of unlike phase, showing that the air was expelled by the former movement and drawn in by the latter. Next came the question of direction, or the lines of force; and

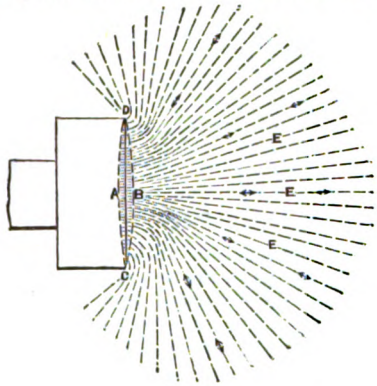

Fig. 15.

here the lecturer arrived at conclusions which marked the most noteworthy portion of his revelations. By an exhaustive series of tests he had discovered that the directive lines of force operating in these experiments were identical with those of magnetism, and when diagrammatically represented corresponded precisely with the familiar lines of a "magnetic field." The identity, we

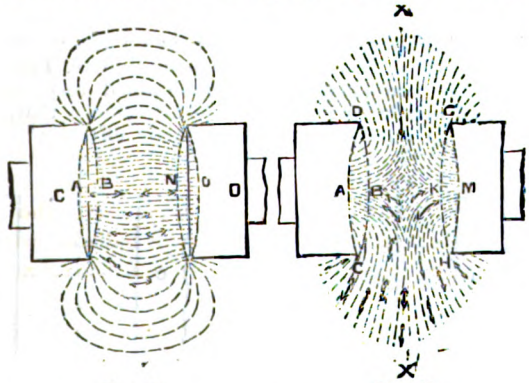

Fig. 16. Fig. 17.

say, was complete in every particular except that, for obvious reasons in the case of the membranes, the forces did not operate beyond, or only very feebly beyond, the margins. Mr. Stroh, at great pains, explained why the currents of air took these directions—explanation the more needed because some of the effects appeared to be contrary to common experience.

The direction and amplitude of the vibration were shown by a little gas jet, Fig. 14, A. If placed in front of membrane the jet takes more or less the form shown in the other figures, and by moving the jet in the vibrating field a fair idea of the form can be obtained. Fig. 15 shows the vibrating field of a single membrane, Fig. 16 of two membranes in like phase, Fig. 17 of two membranes in opposite phase. The dotted lines represent the amplitude, the arrows the direction of vibration. Fig. 18 represents roughly the vibrations of an imaginary disc of air looking in the direction of the axes, E being the circle of greatest

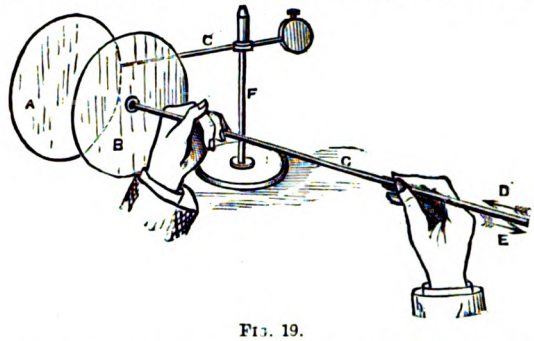

Fig. 19.

amplitude. After the explanation referred to, Mr. Stroh showed an experiment which illustrates the effects in a striking manner.

If a disc of cardboard be suspended (Fig. 19), and another disc, having a rod attached to the back of it, be forcibly projected towards the suspended disc, the expectation is that the latter will fly away; but in reality it does no such thing. A careful

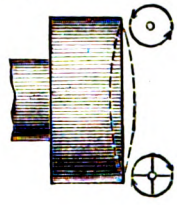

Fig. 21.

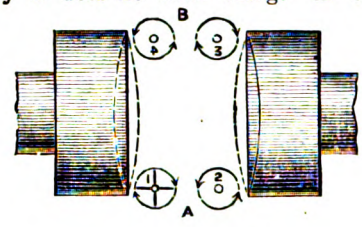

Fig. 22.

watch shows that it recedes just a little, but instantly recoils, and is then attracted towards the projected disc — or, more correctly, as Mr. Stroh explained, the air ejected from between the discs causes compression outside, and a consequent impulse behind, which brings the discs together. Similarly a disc at the end of a light, balanced beam, and turning on

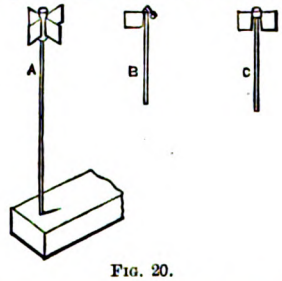

Fig. 20.

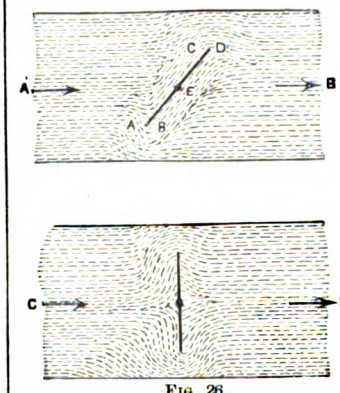

Fig. 26.

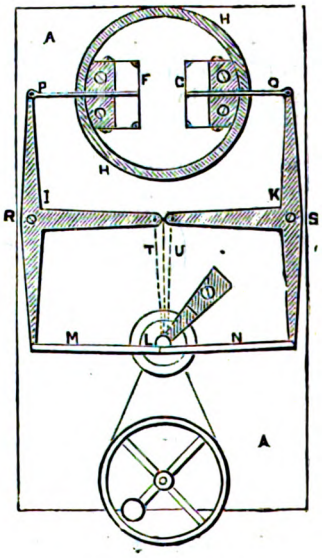

Fig. 23.

a centre, can be made to revolve by a rapid to and fro motion of another disc in the direction of the operator, when we should have predicted motion in the contrary direction. As an illustration of the first movement mentioned, the membrane of the drum may be wetted, and if caused to vibrate the water collects in the centre. The second effect can be ascertained by means of the

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gas jet. The air currents set up were investigated by a little windmill, Fig. 20. Its action with a single membrane is shown in Fig. 21, and with two membranes vibrating in like phase in positions 1, 2, 3, 4, Fig. 22, it turns in the direction of the arrows. The action of such windmills could not be shown except under glass covers and by close inspection. For the purpose of the lecture, therefore, he had contrived imitation membranes and mills working in a medium of glycerine on glass, so that the action could be magnified and projected on a screen. A tiny crank and pulley (Fig. 23) caused two elastic strips to oscillate, and between these, pivoted on four points, were four star-like wheels. The oscillating movement imparted to the glycerine a

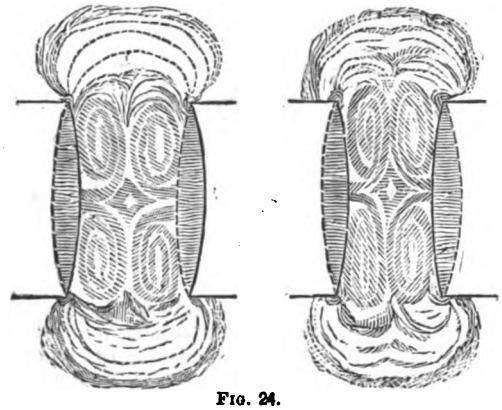

Fig. 24.

certain motion, the direction of which could be seen by the movement of the wheels. By altering the gear of the crank the character of the oscillations was varied, and, in the case of two membranes in unlike phase, the currents, though strong, are uncertain in direction. Since all the vibrating particles have a tendency to move towards and along the central line, the out-

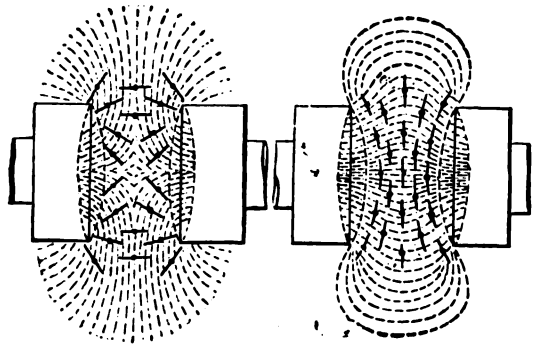

Fig. 25.

ward current takes probably the weakest part of the field, for it is found that generally in one and sometimes two of the places indicated in Fig. 24 the current is reversed. Fig. 24 illustrates the case of one membrane vibrating more strongly than the other, and when this happens in unlike phase the air currents near the stronger vibrator tend towards the centre. On Fig. 23

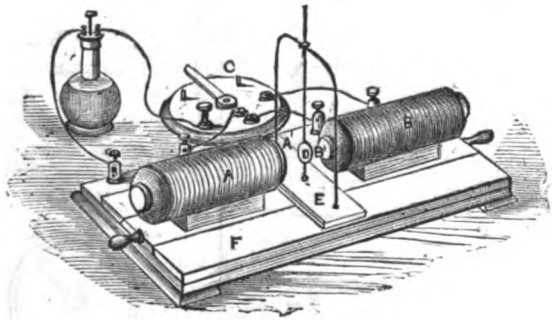

Fig. 27.

H is a rim forming a trough to contain a viscous fluid. In the trough are two thin steel springs, F and G, attached to small frames by hinges, and they represent vibrating membranes. To F and G are attached the rods P and Q, acted on by levers I and K, centered at R and S. The crank L gives a reciprocating motion to the levers. This motion, in fact, is used to cause the springs to move in like or unlike phase. When the trough is filled with glycerine on which bronze powder is sprinkled, the effects represented in Fig. 24 are obtained. In Fig. 25 A represents the field in like, and B in unlike phase. In order to investigate phenomena that were noticed with the windmills —viz., that the vanes had a tendency to stop in a certain postion—the following apparatus was devised to determine which pair of vanes was acted upon. If in Fig. 26 an obstruction be placed in air or fluid moving from A toB, the particles arrange themselves as shown, the particles separating about A in the

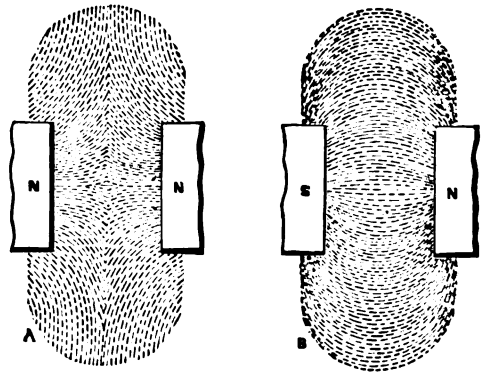

Fig. 28.

upper figure; but if the obstruction be placed as in the lower figure the separation takes place nearer the centre.

If the air or fluid vibrate, there would be alternate impulses on the disc at A, or between A and the centre E, on the one side, and at D, or between D and E, on the other, till the disc was placed at right angles to the current.

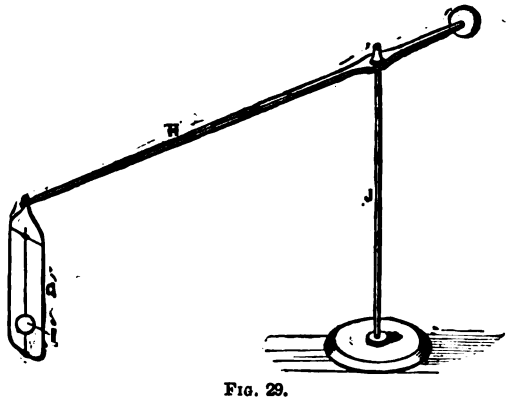

Fig. 29.

For more direct comparison with magnetism the apparatus (Fig. 27), was devised to show the resemblance of the results shown in Fig. 25 with those from a small iron disc between magnetic poles. On the board F are two electro-magnets, A and B, so arranged that their poles can be separated or brought nearer

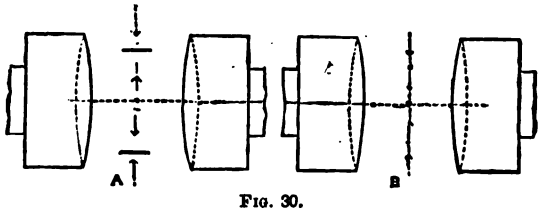

Fig. 30.

together. A current reverser, C, acts on the magnet B, and poles A and B can be made similar or dissimilar. Fig. 28, A and B shows the two magnetic fields obtained respectively with similar and dissimilar poles. It was also shown that, by means of the disc D on the stand E, magnetic effects were obtained

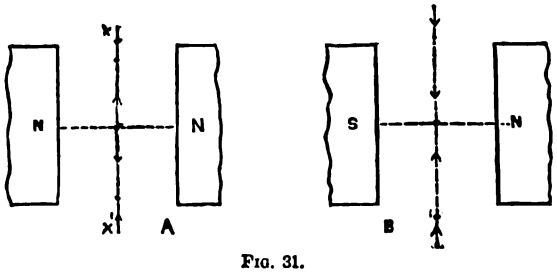

Fig. 31.

which, when compared with those obtained by means of the vibrating diaphragms, were just of the opposite character. The force acting on the disc is not at all points alike. Fig. 29 shows an iron disc, I, suspended by frame G to beam H, long enough to pass one of the electro-magnets (Fig. 27), or one of the

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drums (Fig. 16), and resting by a cup on a needle point, J. If used with apparatus (Fig. 12 of our last issue), G passing freely between the drums when they vibrate in like phase, it places itself centrally, and at right angles to the axis of the drum and in Fig. 30 B, and parallel when in unlike phase. If used with the magnets (Fig. 27), so that the disc plays freely between the poles, it arranges itself as in Fig. 31 B when the poles are dissimilar, and as in 31 A when they are similar. Our description of these beautiful experiments and apparatus has necessarily been brief, but we trust sufficiently clear to enable our readers to understand the scope of the investigation.

Summing up the various conclusions to be drawn from these phenomena, Mr. Stroh could not resist the conviction that, although the motive power was different, and in one respect, at least, the behaviour was reverse the one to the other, the mode of action and its chief characteristics in magnetism and in acoustic vibration were identical, suggesting the idea that magnetism was itself a form of vibration. Possibly, then, investigations might assist in discovering the still hidden source of magnetic vibrations; and here he would leave the matter in other hands than his.

Professor GUTHRIE, after the applause which repeatedly acknowledged Mr Stroh's lecture had subsided, expressed his warm gratitude for the beautiful and instructive discourse they had listened to. Mr. Stroh had referred in one part of his address to Dr. Guthrie's discovery some years ago of the attractive power of a vibrating tuning fork; but he (Dr. Guthrie) could make no pretensions to having even suggested the line of experiment entered upon by Dr. Bjerkness, and now carried forward to such a brilliant stage by Mr. Stroh. He was sure the subject could rest in no better hands than in Mr. Stroh's, and it was greatly to be hoped that he would not rest from his labours.

Mr. W. H. PREECE, Professor FORBES, and Professor FORSTER spoke in eulogistic terms of the lecture, from which important results might reasonably be expected. The first-named speaker, Mr. Preece, ventured to suggest that Mr. Stroh had not done his theory quite justice in one particular, namely, in calling the action of the magnet and that of the membranes inverse to one another. It arose, he thought, from a mere verbal distinction with reference to the like and unlike phases of vibrations. They were alike, it was true, when side by side, as represented in a diagram; but placed opposite each other the membranes which nominally were in like phase, were practically in unlike phase. Similarly, two membranes vibrating in unlike phase fitted each other exactly when brought close together, and therefore might be called like. Translating this nomenclature into that of magnetism, the identity of the two classes of phenomena seemed to him to be complete even in this particular, like poles and like vibrations repelling, unlike poles and unlike vibrations attracting.

Mr. STROH was about to reply to questions and respond to an enthusiastic vote of thanks, when

The PRESIDENT announced that it had been suggested by several members of the Council that Mr. Stroh should be asked to repeat his lecture at a future meeting. If this request were acceded to due notice would be given; and he was sure that the fame of this night's proceedings would spread so that a very much larger audience would await Mr. Stroh's reappearance.

PHYSICAL SOCIETY.—APRIL 22.

The PRESIDENT stated that copies of the Report of the Lightning Rod Committee could be obtained from Dr. Guthrie, Science Schools, South Kensington, price 5s.

Mr. J. M. WHIPPLE exhibited the magnetograph curves obtained at Kew during the past week, showing the progress of the recent magnetic storms. After stating that two unusually large spots were now passing over the sun's disc, he remarked that, although the magnets at Kew were somewhat disturbed on the 14th April, they were nearly stationary until the night of the 16th, when, about 11:45 p.m., they became strongly affected, and from that time till 8 p.m. on the 17th the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0·05 mm., m.gr.s. below its average value, and the vertical component by about 0·07 of the same units. This happened about 6 a.m. of the 17th. A little after noon of the same day both forces became so increased that the light spot left the scale of the instrument for nearly two hours. A second period of magnetic disturbance commenced about 3:40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7:45 a.m. of the 21st. During this period the magnetic force, though fluctuating largely, did not experience such great changes of intensity as were indicated by that of the 17th. Mr. Whipple then alluded to the work of Prof. W. G. Adams, and suggested that the sun's spots only produced effects when cutting certain lines of force, which he imagined might extend for a limited angular distance round the earth's radius sector.

Professor ADAMS pointed out the desirability of increasing the number of self-recording magnetic observations, especially in the southern hemisphere, and after mentioning that the French were about to equip such an observatory at Cape Horn, expressed the wish that the Cape of Good Hope observatory might again be provided with magneto-meters.

The Rev. S. J. PERRY remarked on the exceptional nature of the storm which he had seen recorded at Brussels, and stated that in Belgium the telegraph service had been disorganised by it. Attention was also called to the auroral display in America, and Mr. Lecky, Dr. Guthrie, the President, and others, spoke on the general phenomena of the storms. Large spots were now passing over the sun's disc. He remarked that, although the magnets at Kew were somewhat disturbed on the 14th, they were nearly stationary until the night of the 16th, when, about 11:45 p.m., they became strongly affected, and from then till 8 p.m. on the 17th the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0·05mm. m.gr.s. below its average value, and the vertical component by about 0·07 of the same units. This happened about 6 a.m. of the 17th. A little after noon of the same day both forces became so increased that the light spot left the scale of the instrument for nearly two hours. A second period of magnetic disturbance commenced at about 3:40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7:45 a.m. of the 21st. During this period the magnetic force, though fluctuating largely, did not experience such great changes.

It was then announced that the meetings of the Society in May would be held on the 6th and 20th, instead of on the 13th and 27th, as previously announced; also that the Society would meet at the Clarendon Laboratory, Oxford, on June 17, by invitation of the president.

ON THE SPECIFIC RESISTANCE OF MERCURY.*

BY LORD RAYLEIGH, F.R.S., PROFESSOR OF EXPERIMENTAL PHYSICS IN THE UNIVERSITY OF CAMBRIDGE, AND MRS. H. SIDGWICK.

The observations detailed in the paper were made with a view of redetermining the relation between the B.A. unit and the mercury unit of Siemens, *i.e.*, the resistance of a column of mercury at 0°, one metre in length, and one square millim. in section.

According to Semens's experiments,

1 mercury unit = ·9536 B.A. units,

and according to Matthiessen and Hockin,

1 mercury unit = ·9619 B.A. units.

The value resulting from our observations agrees pretty closely with that of Siemens. We find

1 mercury unit = ·95418 B.A. units.

Four tubes were used to contain the mercury, of lengths varying from 87 to 194 centims. The diameter of the three first tubes was about 1 millim. and that of the fourth about 2 millims. The final numbers obtained from the several fillings of the tubes are as follow:—

Tube I.	·95386 ·95412 ·95424 ·95436 ·95421	·95416
Tube II.	·95389 ·95414 ·95437 ·95436	·95419
Tube III.	·95424 ·95418 ·95399 ·95425	·95416
Tube IV.	·95440 ·95415	·95427

Combining the results of the present paper with our determination of the B.A. unit in absolute measure, we get

1 mercury unit = ·94130 × 10^9 C.G.S.

* Abstract of a Paper read before the Royal Society on 4th May.

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THE ELECTRICIAN.

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TO OUR READERS.

At the commencement of our next volume we intend to permanently increase the number of pages in each issue. With the first number, to be issued next week, we hope to have ready a Supplement relating to the "Dip and Span" of wires. Our second Electric Light Supplement will also be issued with one of the early numbers of the volume. We shall be glad if intending subscribers will commence their subscriptions with the volume, inasmuch as we find it impossible to guarantee the supply of back numbers.

ELECTRIC LIGHTING.—A WORD OF WARNING.

In financial not less than in political affairs it is easy to raise the storm, very hard to control it. Once let loose on an unthinking multitude the elements of conflict, either as a bait for greed or an incentive to sedition, chance alone seems to determine what the end will be. Fortune may favour the wise and the good in both cases; but, as likely as not, panic and ruin may follow in the train of the one as anarchy and assassination do of the other. A deplorable example of political ill-fortune fills the news columns of our daily papers as we pen these lines, and men's minds are occupied with it almost exclusively. Yet if we turn our eyes to the money articles of those same prints we see the foreshadowing of something of a like kind—on a small scale, to be sure, and far below it in public importance, but something that may result in financial misfortune to everybody concerned—and we regret to say that this something has reference to electric lighting.

The truth is the electric light may be said to have temporarily parted company with science, and to be careering on its own account in the precincts of the Stock Exchange. So remarkable have been its antics in that quarter just lately that even the hardened *habitués* are taken aback. We refer, of course, to the shares, not to the lights; and in respect to the former their recent tendency to inflation, glamour, and meretricious blaze has far exceeded anything that their worst enemy has ever said about the lights. The money articles of the newspapers are consequently remarking upon this state of things at greater length than is customary, and with something more than their usual degree of ambiguity. Between the desire to do their duty, by warning the public against possible mishap, and anxiety not to spoil a legitimate market, the writers of these articles are in difficult plight; but for those who care to be warned it is plain that serious warning is intended, and with seeming good reason.

We have said that for the moment electric lighting enterprise, at all events that portion of it upon which we are now particularly commenting—has snapped the reins, so to speak, of the scientist, and is now being ridden by the speculator. In the permanent interests of electric lighting we should have preferred a steadier, if a slower, rider. The experimental stage, in our judgment, had not yet been passed; we wanted to see this and that system exhaustively tested under every conceivable conditions; and especially we desired to see large districts completely supplied on a scale commensurately large. The attainment of these objects would have made comparison with gas illumination both simple and trustworthy. We are as confident as ever that this will be accomplished in the long run, and that the result will be favourable to electricity. But these proceedings in the share market tend rather to delay this much-to-be-desired result—first, by encouraging the formation of an indefinite number of subsidiary companies; and, secondly, by the disappointment which will almost inevitably overtake the investors in such companies.

The actual facts of the situation may be set forth in very few words. One or two large companies have advertised themselves, to use a familiar expression, regardless of expense. The public have accepted this as evidence of the intrinsic superiority of the system owned by the companies who show such unmistakable signs of "go," and a rush for their shares has ensued. According to the authorities from which we have been quoting, the property of some of these concerns is quoted in the market at three or four times its paid-up value. There naturally follows a demand for fresh companies, whose shares will, it is imagined, in due time be equally valuable. The new companies are soon forthcoming, and, to facilitate matters, an original company obligingly grants licenses to work its system in a fresh area—for a consideration. The more numerous the licenses the more lucrative is the business of the parent company. But that business, be it observed, is not electric lighting business; it is the business of selling concessions to other intending businesses. The electric lighting part of it may be profitable or it may not; we are quite in the dark as to that, or nearly so, just when we stand most in need of enlightenment. Possibly some of the licensed companies may pay their way, possibly they may do a stroke of business themselves in the way of sub-letting—a business obviously more profitable than that of either gas or electric lighting; but the limit to this source of revenue is soon reached, and in any case the receipts can never attain the proportions apparently earned by the original company. On the contrary, it taxes them to its own profit and the buyer's loss.

This is not a good look out for the multitude of new companies just now creating what one newspaper calls a "mania" and another a "fever" on the Stock Exchange; and it does not improve the immediate prospects of electric lighting. Such an artificial state of things as that we have been describing is certain to end in disappointment, and in some instances possibly in disaster, to the discredit of electric lighting and all the financial operations concerned with it. It is, perhaps, no part of our duty to emphasise the risks of buying shares at their present high premiums—though we do not hesitate to make those risks clearly understood—but it is our province to further to the best of our ability the true interests generally of electric lighting systems. One such interest clearly lies in having a fair field for all competitors, so that the best of them may speedily win. The systems which are the subject of these comments may be good, but the method adopted in promoting them is certainly not wise; and—again reverting to our political comparison—as the wise are by no means always good, any more than the good are uniformly wise, we cannot but regard this new departure in the history of electric lighting with some degree of uneasiness, not to say alarm.

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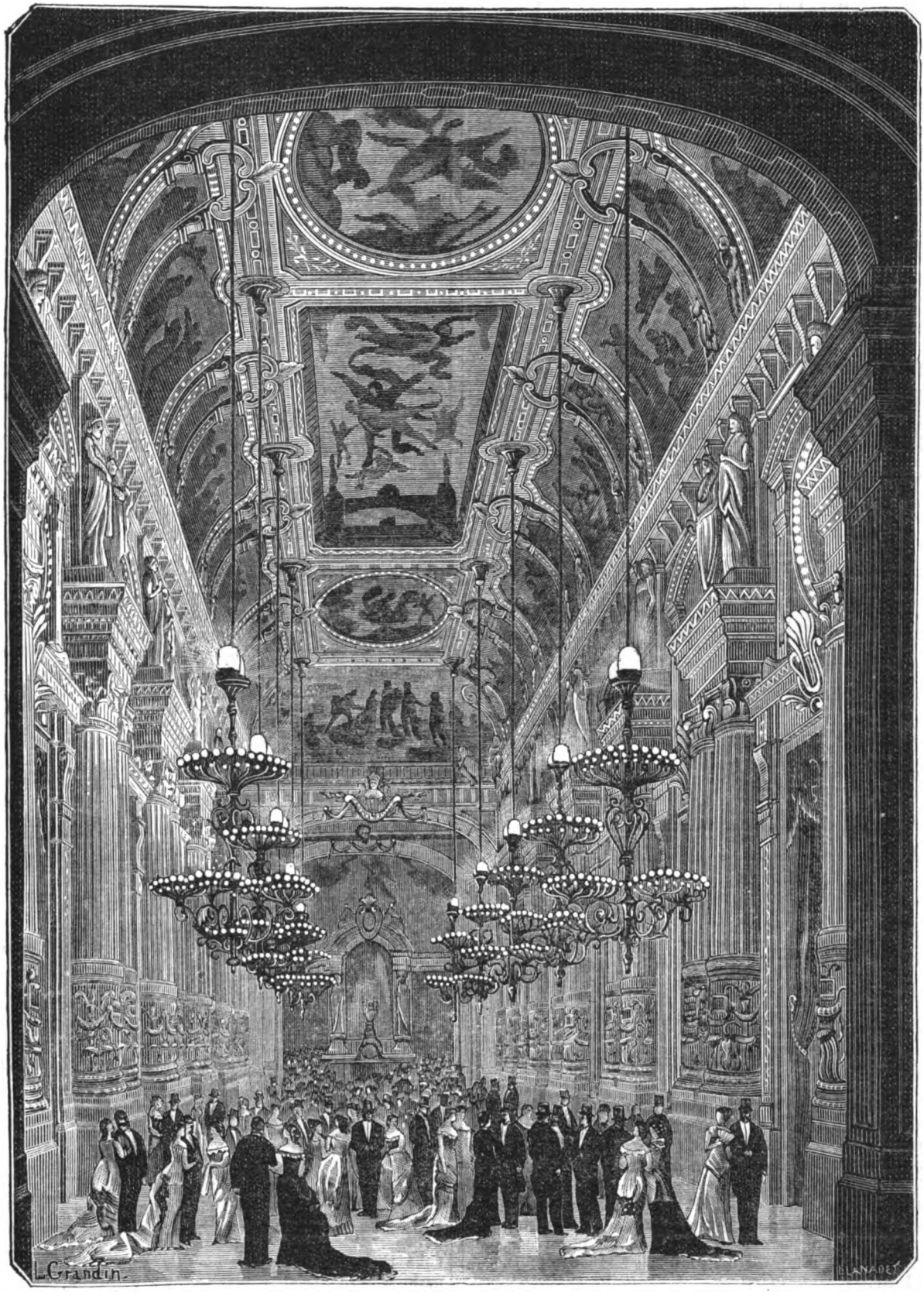
ELECTRIC LIGHT IN THE OPERA HOUSE, PARIS.

Our illustration represents the *foyer* of the Opera House in Paris, lighted up by the Soleil and Edison lamps. It will be remembered that some time since experiments were made with the Maxim, Edison, and Soleil lamps, as a means of illuminating the *foyer* and the two rooms adjoining. Maxim lamps were used to light these two rooms, and Edison and Soleil lamps combined did duty in the *foyer* itself. The Soleil lamps were mounted two on the top of each cluster of Edison lamps, and were so placed as to throw their light on the magnificent paintings of the ceiling. The effect is said to have been beautiful, the paintings being particularly well shown by the new lights. We are indebted for this illustration to our excellent contemporary *La Lumière Electrique*.



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THE CRYSTAL PALACE EXHIBITION.

The Hawkes Electric Light.

Passing from the Picture Gallery towards the big clock the visitor will come to the Hawkes arc lamps. We have previously mentioned this lamp, but, so far as we know, the Palace installation is the first complete exhibition of the system that has been before the public. In this lamp the regulating mechanism is below the carbons. The arc is established by the passage of the main current over an electro-magnet in the positive circuit. This magnet actuates its armature, and, by that means, makes the arc, which is then regulated and retained at its proper length by the action of an electro-magnet in a branch circuit. The lower

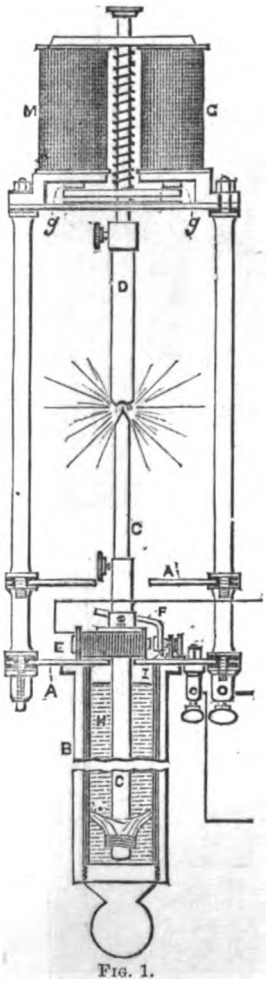

Fig. 1.

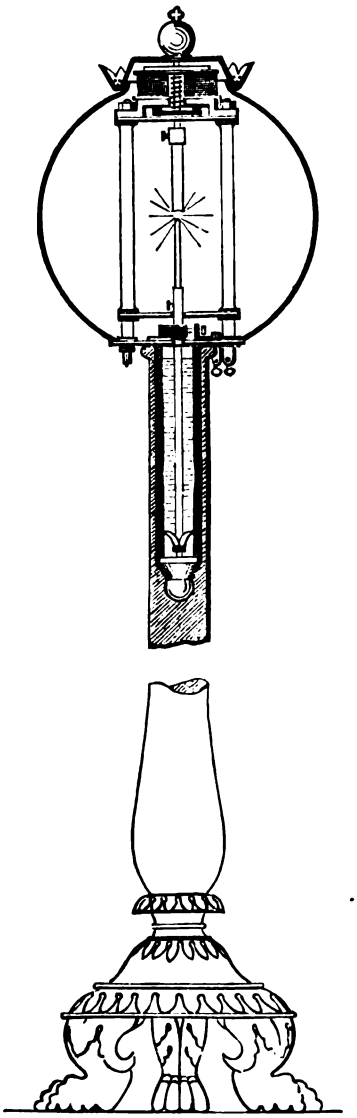

Fig. 3.

carbon is controlled by the branch magnet. Fig. 1 is a section of the lamp. M C shows the upper magnet, *g g*, the armature to which the positive carbon D is attached. The negative carbon holder C goes into the mercury H in tube B. The regulating gear consists of magnet E, with its armature attached to a clutch F, turning upon two pivots. This clutch acts upon the lower carbon holder, allowing it to ascend according to the size of the arc. A more complete description of this lamp will be found in our issue of December 17, 1881.

It is difficult to judge the comparative values of arc or even incandescent lamps without exhaustive tests, but the inventor claims great power, softness, and steadiness. He also claims that his lamp may be trusted to perform its work without breakdowns. The lights can be maintained either in series or in divided arc. The suspension lamp is illustrated in Fig. 2. The posts for the short lamp, Fig. 3, have been specially manufactured by the Thames Iron Works. The

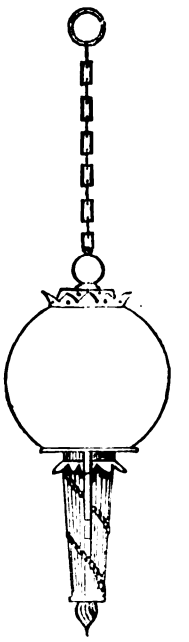

Fig. 2.

current for these lights is obtained from Gramme machines driven by Hodson's rotary engine described below. Mr. Hawkes is the only exhibitor using rotary engines exclusively.

Hodson's Rotary Engine.

So many attempts have been made to produce a satisfactory rotary engine, and always unsuccessfully, that it is a somewhat curious coincidence to find an engine of this class having better mechanical arrangements, and offering more reasons for success than any of its predecessors, just at the

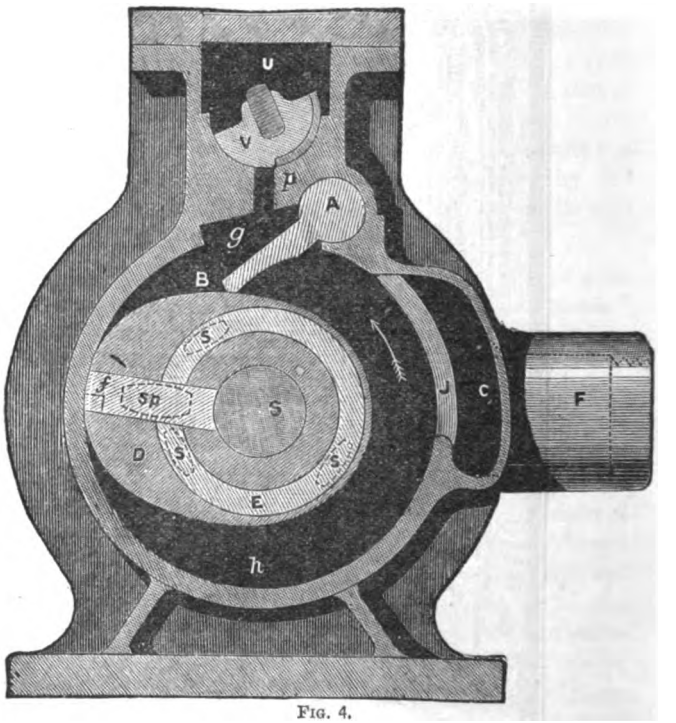

Fig. 4.

time that the extensive employment of dynamo machines make a high speed rotary motion essential. It is certainly not too much to say that Mr. Hodson's engine is the best design yet made public, and the extensive trial which it has already secured ought to provide that experience which is necessary to the perfection of any such piece of mechanism. In our illustrations, Fig. 5 shows the engine as fixed on the

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same bed plate and attached direct to a Gramme machine. Fig. 4 is a transverse section, through one end of the engine cylinder, just within the cylinder cover. The cylinder is divided lengthways by a diaphragm, thus turning two cylinders. Two piston cams D are keyed on the shaft S, one on each side of the diaphragm, and rotating in the direction of the arrow. These pistons are placed on the shaft in opposite positions to each other, by which arrangement the engine is balanced, and when the steam is exerting full power upon the one, the other is open to the exhaust, so that nearly equal pressure is maintained throughout the revolution of the shaft, and regularity of rotation and steadiness ensured. A is an abutment valve fitting into a recess in the cylinder; the tail of this valve rests on the surface of the cam as shown, and rises and falls as the piston rotates. The pressure of steam on top of the valve keeps it steam tight, and a cushion of steam at *g* prevents striking the top of the cylinder. There is a steam port on each side of the diaphragm, by which steam is admitted to the two pistons by an oscillating valve, V. This valve is worked from an excentric (Fig. 5) on the shaft, and admits steam to each piston alternately, the eccentric and valve being the only reciprocating parts.

The excentric is set on the shaft, so that the steam is admitted by the valve V at the moment the point *f* in the cam arrives at the point *g* in the cylinder, and cut off when F arrives at *h*. The steam enclosed in the space B is then allowed to expand until *f* arrives at J, when the steam commences to escape into the exhaust cavity C, and thence through the branch F.

The steam is thus cut off at about half-stroke. Only metallic packings are used, glands and stuffing boxes being dispensed with.

The rotating shaft bearings in the cylinder are kept steamtight by the pistons working closely against the diaphragm. The pistons are packed at the cover end by rings E made of phosphor bronze, and there seems to be very little wear on these packings, and their appearance after running for some time indicates that they remain practically steamtight.

No doubt Mr. Hodson has tried many forms for the valve V, but we should be inclined to think that a rotating valve might be made, and if so, this would reduce some of the vibration which is noticeable when the engine is running at a very high speed. Mr. Norwood Earle, of 80, Cannon-street, is the patentee's agent.

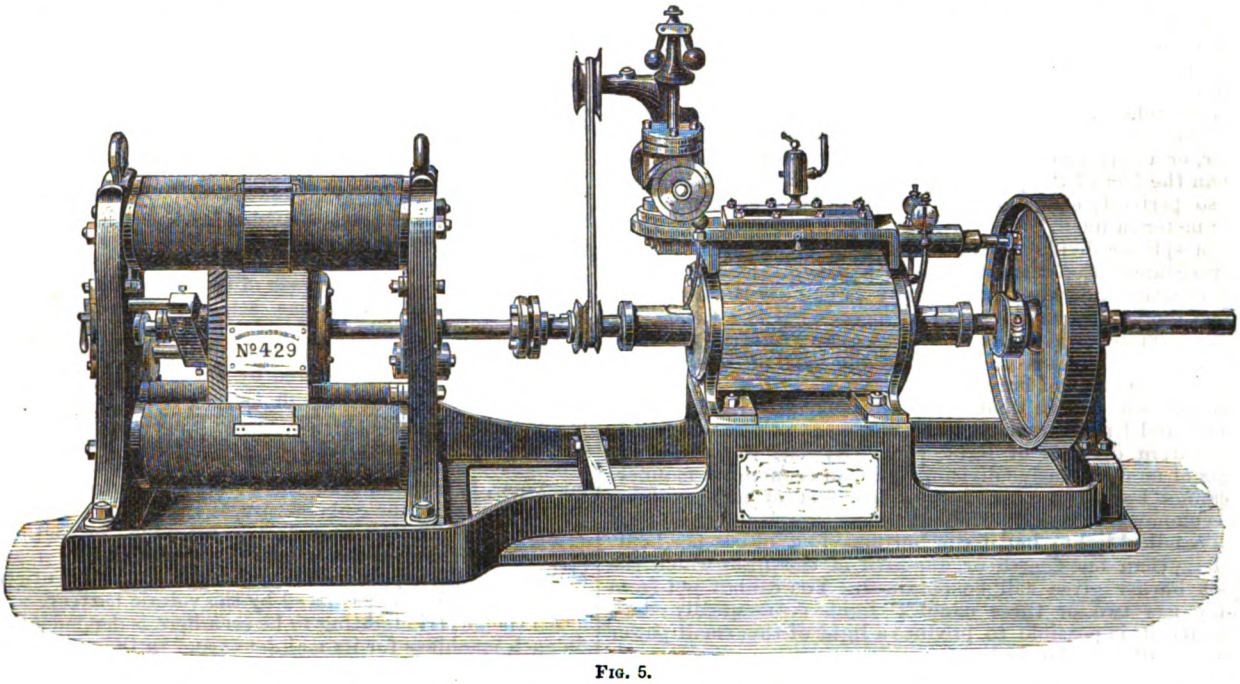

Fig. 5.

ELECTRIC LIGHTING BY INCANDESCENCE.

BY J. H. SWAN.

(CONCLUDED FROM PAGE 413.)

In producing light by incandescence, it is essential to economy that the incandescing material should be made hot enough to raise it to an extremely high pitch of incandescence, for it is only after a certain considerable temperature has been obtained that light begins to be emitted, and the hotter the heated body is made the more light is given off proportionally for a certain increment of heat.

I will illustrate this extremely important point. Here, enclosed in a vacuous globe, is a thin filament of carbon. I will pass a certain amount of current through this filament sufficient to produce a light of about two candles.

If, now, I increase the current by one-half, and in doing so expend not quite twice the energy which was expended in producing the two-candle light, I obtain not *double* light for double energy expended, but *fifteen* times the light.

[The experiment described was here made.]

This experiment clearly shows the great advantage of employing an extremely high temperature in incandescent lamps, and how important it is to construct them in such a manner as to be durable while the filament is raised to a point of extreme incandescence.

Metals, such as platinum, have been persistently tried as the incandescing material of electric lamps, but no practical results have been arrived at through their use, chiefly for the reason that no metal exists, so far as we know, capable of bearing the extremely high temperature necessary to be reached before the quantity of light emitted is large enough in proportion to the quantity of electricity employed to give an economical result. The only substance so far successfully employed for this purpose is carbon—carbon in the form of an extremely thin filament. All the incandescent lamps in the Palace have carbon as the incandescing material. The different incandescence lamps differ chiefly in the mode of forming the incandescing carbon filament. The lamps hung aloft are, I believe, formed from slender splinters of bamboo. Those on the table are formed from cotton thread treated with sulphuric acid.

Here is a highly enlarged image of a filament of carbon, such as is used in my lamp. The filament is fixed at one end and loose at the other. The loose end is loaded to show how wonderfully elastic this form of carbon is.

The various lamps differ from each other chiefly in respect of the particular mode of manufacturing the extremely thin filaments of carbon, and minor details.

Carbon, as you know, is combustible. It is necessary, therefore, to prevent combustion of the filament by exhausting the air from the bulb which contains it. This is usually done by a mercury pump. A good vacuum is not only necessary for the preservation of the carbon filament, but greatly tends to economy

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by limiting the cause of cooling to radiation, whereas if a gas of any kind be present, cooling is increased by the heat-carrying power of the gas.

This method of electric lighting has now been sufficiently tried to demonstrate the all-important fact of its economy, comparatively with other modes of producing artificial light, comparatively even with gas. It is found that one horse-power is capable of producing light equal to 200 candles, and this light may be in ten lamps of twenty candle-power each, or it may be in twenty lamps of ten candle-power each.

Sub-division of the light entails no loss of economy. You may even have forty lamps of five candle-power each for the same expenditure of power.

Here is an illustration of the great extent to which the sub-division of light may be carried economically by means of this principle of electrical incandescence.

[An experiment was here shown. A current was successively passed through a single lamp, through five lamps, and through nine lamps. The current and the aggregate light were the same in each case.]

This is at the same time an illustration of the valuable property which electricity possesses of naturally sub-dividing itself equally among equal resistances.

One sometimes hears the sub-division of the electric current spoken of as if it were a difficult thing to obtain. There is happily no difficulty of the kind; on the contrary, it is more easy to sub-divide a current of electricity than to sub-divide a current of water, or a current of gas. There cannot be a better proof of this than the fact of the possibility of making the light of these lamps so perfectly equal as they are, for each lamp is a sort of electric meter in itself.

If you split or divide a main wire into many branches, all of equal resistance, the current will, with absolute certainty and perfect exactness, divide itself equally among all the branches. This fact renders the distribution of electric current among any number of lamps, so that all shall be equally lighted, perfectly simple and easy—even more easy than the equal distribution of gas among a number of burners.

I have shown you in what small units electric light may be produced, and I must remark with reference to these very small lamps that, in division of light, electricity has the advantage over gas of more extensive divisibility in an economical manner. You cannot burn less than four or five feet of gas per hour in an economical manner. This rate of consumption gives about sixteen candles' light; but if you burn one foot of gas per hour, much less than one-fourth or one-fifth of the light which the five-foot burner gives will be obtained. You cannot get from ordinary gas two or three candles' light economically; but, electrically, it is possible to produce a light of this small power as economically as a larger light.

Here are lamps of greater power, giving, I suppose, each 200 or 300 candle-light. Then the lighting and extinction of electric lamps is easier than the lighting and extinction of gas lights.

[The lamps on the table were here extinguished and re-lighted, then the whole of the lamps in the room were put out and instantly relit.]

It is also *possible* to *reduce* the power of the light, to turn it down as you do gas, but it is not economical, for the reason I mentioned, to do this; but neither is it economical to turn down gas until you have only the blue flame. On this point, and it seems to me an unimportant one, gas has the advantage. Usually we turn down gas very low, because we want to avoid the trouble of relighting the gas; but with electric light there is no trouble of the kind; no matches are required; you go to a dark room, and even before you enter it, by touching a knob at the entrance, as if by magic the room is instantly lighted up. Sir William Thomson has his house completely lighted with incandescent electric lamps, and I have seen there exactly what I have been describing.

Among the many advantages of electric light, I must not omit to mention the entire absence of air contamination in rooms lighted by incandescent lamps. As the luminous carbon filaments are completely enclosed in glass they do not come into contact with the air, consequently the air of a room electrically lighted is not in any degree poisoned in the way the air of a gas-lit room is; and, considering what a large portion of our time is spent in artificially-lighted rooms, the beneficial influence of the superior purity of the air of electrically-lighted rooms on health will evidently be very great. But not on health only, considerable advantage will also be reaped in the avoidance of damage to furniture, to books, to pictures, and the decorations of houses, and goods in shops. Even if electric light were not the economical light which it really is when light alone is considered and not its secondary effects, it would in very many cases be cheap at double the price of gas, considering the destructive effects of gas; but, happily, we can have the advantages of electric light at a cost not greater than the cost of gaslight.

I do not mean that you can all have electric light put into your houses to-morrow, and at this very economical rate. Before this state of things is possible large electric lighting stations will have to be established on something like the scale, and probably at something like the cost of gasworks.

In those electric light works numerous steam engines of the largest size will be employed to drive dynamo-electric machines like this machine in principle (referring to Siemens's dynamo-electric machine on the platform), but of a much larger size. I do not doubt that before long there will be electric supply companies in every town in the kingdom, supplying current for lighting the lamps in your house from a main wire, coming from a main central works, and running through the street, as the gas pipes now do. But pending that, I hope, not far distant time, it is necessary for those who determine to have electric light to provide themselves with the means of generating electricity.

Electricity may, as you all know, be generated by a battery of voltaic cells, but except as a means of storing up the energy of some electric generator less costly in its operation, such as this dynamo-electric machine, which it may not be convenient to keep always working, these voltaic cells are practically useless for our purpose. Used in a *secondary* manner, as *reservoirs* of the electrical energy developed by a dynamo-electric machine, or for the purpose of steadying the current and accumulating its effects, secondary voltaic cells are likely to play an important part in electric lighting arrangements, but as primary generators they are far too costly. The only economical means at present available for the primary generation of powerful electric currents is the dynamo-electric machine, of which there are, in actual operation at this moment, numerous examples in this building.

The reason why electric lighting has become so important of late years is the great increase of economy in the production of electric currents which has attended the invention of the dynamo-electric machine, of which here is a specimen constructed by Messrs. Siemens. This and all dynamo-electric machines depend on the fact, discovered by Faraday, that when a mass of wire is put in rapid motion in close proximity to the poles of a magnet an electrical current is set up in the wire, and if the current produced is made to react on the magnet so as to strengthen its magnetism, then it is called a dynamo-electric machine. It is found that, the stronger the current developed by the movement of the coils of wire, the more power is required to move them. The dynamo-electric machine, in fact, effects the conversion of motive power into electricity, and the result is that electricity can be produced at one-tenth or one-twentieth of the cost at which it was produced by the voltaic battery.

All the electric lighting to be seen here is dependent primarily on such machines for its maintenance. In the meanwhile, therefore, we must provide dynamo electric machines and motive power to drive them before we can have electric light.

I mentioned that the use of secondary voltaic cells tends to the production of *uniformity* in the current, and the result of this is *uniformity in the light*.

Absolute steadiness of light far beyond that we usually experience with gas is one of the attendants of a steady current supplied to the incandescence lamps. This is a minor advantage, but still a very appreciable advantage in favour of electric light of the character I am considering.

I feel sure that it will be expected that I should tell you whether I think there is any danger of an electric shock being given by the wires employed in electric lighting. I think that this danger is so remote that it is not worth considering, except by those who lay the wires. When electric lighting comes into common use, the wires will be so laid that meddlesome fingers will not easily get at them. This precaution being taken, the danger will be quite as remote as the danger of burnt fingers at a gas flame, and not even so serious. These lamps, acting on the principle of incandescence, when well made, are so durable that they will not often require renewal, but when they do require renewal there is neither difficulty nor danger attending the very simple operation.

[It was here shown how simply a lamp could be attached and detached from its socket.]

At the present moment electric lighting is very much in the same position that gas-lighting was before the establishment of gasworks by gas companies. At that time the only way by which it was possible to light a house or shop with gas was to fit up a small gasworks for the special supply of the house or shop. In the case of large houses or factories the difficulty was not serious, and independent works were, and still are, established for gas-making for the sole supply of some large mansion or works; but gas-lighting did not become general until all the trouble and cost of erecting and maintaining a separate gas-manufacturing establishment was taken off the hands of the

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consumer by large companies, who manufacture gas on a large scale, and supply it through main pipes for less cost than the user could possibly produce it on a small scale for his own use.

That the erection of such electric-light stations as I have referred to cannot long be delayed, we have the strong guarantee of the incontrovertible fact, that electricity, through the medium of incandescent lamps, is an economical means of obtaining artificial light, and that it is capable of adaptation to all the ordinary uses of such light.

The cost of this mode of producing light is comprised in two items—the cost of lamps and the cost of electricity. With reference to the cost of lamps two points have been established—that they can be *manufactured cheaply* and that they are *durable*, and that, therefore, the charge on the light, occasioned by the cost of maintenance of lamps, is *small*—probably two or three shillings a year will cover this expenditure—*reckoned at cost price* and for ordinary hours of use, say 2,000 hours. As to the cost of the *electricity* for keeping the lamps lighted during this period :—Assuming that the motive power employed is that of the steam engine, and that it is produced in the most economical manner on a very large scale, the coal necessary to develop this power would not cost more than one-third as much as the coal required to produce gas of equal lighting effect, even after allowance has been made for the value of the residual products of gas manufacture.

The minor difficulties of measuring the current to each individual consumer, after the manner of measuring gas, and of regulating the supply of current to the demand, so that there shall be no waste of power, are, both theoretically and, to a certain extent, practically disposed of, and it is only a question how to accomplish these ends in the best manner. But these difficulties, so far as they exist at all, will disappear under the *pressure* of the *necessity for them being met* and *overcome*, so soon as they are in actual collision with progress.

Already there has been a considerable amount of electric lighting successfully done. Several large mansions are lighted, a number of shops and warehouses, some railway tunnels and railway carriages, many ocean steamers, a coal mine, a chapel, a theatre, a council chamber, and other places of public assembly. Altogether the prospect is hopeful in the extreme. Electric lighting is in the ascendant; but yesterday the idea of producing light for useful purposes by means of electricity was the dream of a few sanguine enthusiasts, and the derision of practical men. One by one the many and great difficulties which beset the path of progress towards the realisation of this bold idea, and which at first seemed well nigh insurmountable, have been triumphantly overcome, till now it is beyond all doubt or question a fully accomplished fact. Electric lighting is now not merely practicable, but it is universally practicable, and practicable with economy, and when that has been proved it is as clearly evident as anything in this world can possibly be that we shall not have to wait long until we are in the full enjoyment of the beneficent results of this, one of the latest and greatest of the many contributions of physical science to the health and happiness of mankind.

INSURANCE COMPANIES AND ELECTRIC LIGHTING.

On Wednesday, May 3, the first of a series of six lectures on the fire risks of electric lighting was delivered at King's College by the evening lecturer on physics, Mr. R. E. Day. The lecturer began by referring briefly to the action which has recently been taken by some of the fire insurance companies in the matter of electric lighting, and attributed the hostility which apparently exists in some quarters, to the general ignorance of the rules which should be observed in the installation of the electric light, and expressed his firm belief that, when a knowledge of the precautionary methods by which electric lighting can be made perfectly safe and harmless become more generally known, then these fears of the risk attending its use will pass away. He then went on to discuss the common statement that electricity is a form of energy. A cannon ball, when at rest, has no working power, and therefore no energy, since the possession of energy means the possession of the capacity for doing work; but when work has been expended on the ball either by lifting it to a great height or by imparting to it a great velocity, then the ball possesses what it had not before, that is, considerable energy or working power. In the same way electricity, whatever it may be, is not of itself energy, but when animated by a quality which is called electromotive force, it possesses the capacity for doing work, and in this condition may be called a form of energy. This was illustrated in several ways. Sir Humphrey Davy's discovery of the voltaic arc was then explained and illustrated. It was shown that when two pieces of carbon, the ends of which are connected with some powerful source of electricity, are brought in contact, and then gently separated, their ends become intensely hot, and the electric current is maintained across the air-space between them. In the original experiment the carbons were horizontal, and the luminous band, having a slightly arched appearance, it was called the electric arch, from which the name arc is derived. It is often said by persons who are ignorant about electricity that the electric light is a cold light, and that this is why it does not heat the air of a room. As a matter of fact, the electric arc is intensely hot, and its high temperature was illustrated by the fusion of several metals, such as zinc and iron. The true reason why it does not perceptibly heat the air of a room is because the heat in it, though of exceedingly high temperature, is very small in quantity, and, therefore, incapable of warming any large mass of air. Ampère's discovery of the electromagnetic properties of the current was then illustrated in various ways, and it was shown that the lifting power of an electromagnet is directly proportional to the amount of heat which is developed in the coils. The attention of insurance inspectors was then directed to the difference between electricity of high and that of low electromotive force, or, as we may say, between high pressure and low pressure electricity. The two are identical in the same sense as that in which the water of a mountain torrent is identical in its nature with that of a great river flowing over a comparatively level bed. The water of the mountain torrent is small in quantity, but has great power of overcoming resistance on account of its precipitous fall, while that of the river is vast in quantity, but of low pressure, as its fall is not precipitous; so also the electricity of a plate machine is small in quantity, but of high electromotive force, while that of the battery is vast in quantity, but of low electromotive force, or pressure. Now, when steam or water are conveyed through a pipe under great pressure, accidents arising from leakage are much more liable to occur than when the pressure of the water or steam is low, and, in the same way with electricity—accidents, which may involve risk to life or property, are much more likely to arise from leakage and defective insulation when high pressure electricity is employed than when the system adopted permits of the electrical energy being supplied at a comparatively low pressure. The various kinds of work—mechanical, chemical, and thermal, which can be done by the current—were then illustrated, and it was shown that, in accordance with the principle of the conservation of energy, whatever work is done in any part or parts of a circuit involves the expenditure of an equivalent amount of energy at some other part. The part played by the leading wires in transmitting the electrical energy from the generator to the locality where it is used was then explained and illustrated. The function of the conducting wires is, in many respects, analogous to that of the steam pipe in an engine which transmits the energy of the burning fuel to the piston, and, just as in the case of the engine, it is important that as little as possible of the energy expended on the furnace should be expended in useless heating of any of the parts of the engine; so one of the main objects of the electrical engineer is to transmit the electrical energy from the source to the point where it is to be applied for useful work with as little loss as possible in the leading wires.

FIRE RISK AND ELECTRIC LIGHTING.

The following letter and extract accompanying it appeared in *The Times* of May 10.—

"SIR: Various conflicting statements have from time to time been put forward as to electric light and fire risk. On the one hand, it has been said that the use of electric light guarantees absolute safety from fire; and, on the other hand, the fact that no less than six fires occurred in the recent Paris Exhibition has caused certain fire offices to actually charge an increased premium when electric light is substituted for gas. We, in common, we think, with other electric light engineers, believe that electric light is absolutely safe if certain definite and well-understood rules are observed in arranging the installations, but that, like every other kind of power, whether steam, gas, water, or animal, it will be a fruitful source of danger if the arrangements are intrusted to ignorant or unskilful hands. When two wires become accidentally connected they sometimes are heated to redness by currents which pass through the wires only instead of through lamps. It appears to us that the subject is one of great importance, as, on the one hand, if the installations are made unskilfully fires will occur, while, on the other, if through blunders in early installations enough fires are caused to alarm the insurance offices electric light enterprise will be seriously hampered by the heavy premiums which will be charged.

"The Phœnix, one of the oldest and largest of our fire in-

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surance offices, have investigated the matter, and as a result have received an admirable report from their engineer, Mr. Musgrave Heaphy, C.E. The report concludes as follows:—

"'And now with reference to the question as to whether the electric light, taken as a whole, is safer or more hazardous than gas; I am of opinion—so far as conclusions can be drawn from the present knowledge of the subject—that where systematic and proper precautions are taken there is less danger from electric lighting than from gas; but that if carelessly or ignorantly arranged, or improperly worked, then serious fires may be apprehended.'

"Mr. Heaphy then gives the following rules, the observance of which will, we understand, be required by the Phœnix on insuring electrically-lighted buildings. We may add that at a recent meeting representing the principal electric light companies these rules met with general approval. These rules are primarily intended for observance in mills, theatres, and generally that class of buildings technically known as 'hazardous risks.' It would, however, in our opinion, be well that their adoption should be everywhere insisted on by the fire offices, as it must be remembered that electricity is now supplied on a very small scale, but that in a very short time it will be supplied on at least as large a scale as gas or water. Apologising for the length of this letter,

"We remain, sir, your obedient servants,
"R. E. Crompton, M.S.T.E.
"J. E. H. Gordon, M.S.T.E."

"Phœnix Rules for Electric Light Installations.

"'1. All rods or wires in a building to be so placed as to be thoroughly and easily inspected.

"'2. All rods and wires to have sufficient sectional area, so as to allow at least 50 per cent. more electricity being safely sent through them than will ever possibly be required for the lights they supply.

"'3. All main rods (or wires) should be thoroughly well insulated with a material rendered as non-inflammable as possible, and further protected by coverings of a substantial and durable character. Wherever practicable the rod (or wires) should be enclosed in iron, brass, lead, terra-cotta, or earthenware pipes, the space between the rod (or wires) and the pipe being completely filled with a high insulating compound. Or the rods (or wires) should be thoroughly well insulated with a material as non-inflammable as possible, and might be placed in slate beading or slate boxes. To be approved by the inspector from the fire office.

"'4. The wires for "arc lights" to be insulated and protected in the same manner as the aforesaid main rods or wires. The wires, unless enclosed in pipes or slate boxes, &c., as described under requirements No. 3, should be laid at least eight inches from each other, and eight inches from all other wires, metal, or conducting substances. Or where this from the nature of the case is impossible, then the wires must be kept at least one inch apart, and one inch from all conducting substances by a continuous rigid non-conducting material, to be approved by the inspector from the fire office.

"'5. The wires for the incandescent lights should be at least two-and-a-half inches from each other, and two-and-a-half inches at least from all other wires, metal, or other conducting substances; they must be thoroughly well insulated with a material rendered as non-inflammable as possible, and protected by coverings of a substantial and durable character; and where external injury is possible they should be insulated and enclosed in iron, lead, brass, terra cotta, or earthenware pipes, or in slate beading or slate boxes, in the manner described in requirements No. 3 for the main rods.

"'(In non-hazardous risks the wires, having been thoroughly well insulated with a material rendered as non-inflammable as possible, should, where practicable, be enclosed in wood beading, and the wires kept apart by a continuous fillet of wood at least one inch wide.)

"'6. All rods or wires passing through floors or partitions must be insulated, and enclosed in iron, brass, terra-cotta, or earthenware pipes, or slate beading, in the manner described under requirements No. 3.

"'7. All rods or wires passing through the exterior walls of buildings must be insulated and enclosed in pipes as described in requirements No. 3, and the insulated material must be impervious to moisture.

"'8. All rods or wires in a building that are exposed to moisture must have a waterproof covering to their insulating material.

"'9. The fastenings of all rods or wires to be composed of an approved non-conducting material.

"'10. Any material employed for conducting the electricity in lieu of rods or wires must be protected in the same manner as the before-mentioned rods or wires.

"'11. All lamps, switches, or any bare connexions must be so mounted that leakage of electricity from them is rendered impossible.

"'12. When two wires are joined together the junction must be soldered or secured by a thoroughly clean binding screw or clamp.

"'13. Wherever a branch wire is led off the main conductor to supply current for one or more incandescent lamps, a short length of lead or other fusible wire must be inserted between the main conductor and one end of the branch; and the lead wire must be of such section and nature that if the current passing through it exceeds the normal current by 50 per cent. then it will fuse and disconnect the branch.

"'14. No naked lights allowed. If "arc lights" are used, the globes must be enclosed at the base, and have chimneys so arranged that no sparks or flame can escape. The globes must also be covered round with wire netting.

"'15. All "connexions," "cut-outs," or "resistance coils," must be placed in such a secure manner that no danger can arise in the event of their heating.

"'16. A shut-off must be placed at the point of entrance to each building.

"'17. No ground circuit allowed.

"'18. All work is to be of a substantial character, and put up in a thorough workmanlike manner, and to be accurately tested at the time of erection for insulation.

"'19. When the "electric light" is intended to be used, information must be supplied of the particular system of lighting that is to be adopted; how and where the electricity is to be generated; the number and kind of lamps used; the quantity of electricity to be conveyed through the wires; the conductive capacity of the wires; method of insulation; whether there is to be metallic circuit; and as far as possible full details of the manner in which it is proposed to equip the building.

"'Musgrave Heaphy, C.E.

"'Phœnix Fire Office, February-April, 1882.'"

THE ELECTRIC LIGHTING BILL.

A meeting of the Select Committee on this Bill was held on Tuesday last, when Mr. Farrar, secretary to the Board of Trade, was examined. In the course of his evidence Mr. Farrar gave the reasons for promoting the Bill as follows:—At the commencement of the session it appeared that there was a very large number of Bills introduced into Parliament containing provisions respecting electric lighting. They might be divided into four classes. First, there were six Bills conferring general powers on companies as the producers and suppliers of the electric light, and enabling them to break up the streets for the purpose. This should be done, however, with the consent of the local authorities. These provisions applied to any towns or districts in the United Kingdom. There were eight Bills in the second class, which enabled existing gas companies to provide the light or power. In none of these Bills, however, was there adequate provision regulating the price or supply. The third class included Bills enabling corporations, or other local authorities, to provide the light or power. There were eight of these Bills. Of the last class, there were eight Bills relating to the lighting of public places as well as of dwellings. Some of these Bills had provision for heating by electricity as well as lighting. In 1879 a number of electric lighting Bills were before Parliament, and were referred to a select committee of the House of Commons. The committee came to the conclusion that gas companies had no special claims as producers and distributors of light, and expressed the opinion that if the electric light question were left to their care its progress would be but gradual. At that time, however, the committee did not consider the time had come to grant companies powers for the breaking up of streets. The Electric Lighting Bill promoted by the Board of Trade avoided interfering with the freedom of any person to make and use electric power on his own premises so long as he did not injure any other persons. Neither did it prevent any person supplying electric light or power to other persons provided they did not interfere with private rights or property. As the electric light was undoubtedly in its infancy, special provisions were made for facilitating experiments. For such

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experiments, which would probably be frequent, there would be no necessity to come to Parliament at all, as provision was made for the granting of a license by the Board of Trade for a period of seven years. No regulation was made as to the particular character of the lamp to be used, because a special system of lighting was invariably connected with a particular form of lamp. Power was given in this Bill, for the first time, to electric light companies to break up streets, and to erect posts for the purpose of their lighting. One of the most important objects of the Bill was to prevent the creation of a monopoly acting against the interests of the general community. The ordinary governing body of a town ought, in his opinion, to have the preference in supplying the electric light, whether they were at present supplying gas to the town or not, and whether the person supplying gas were a company or a municipal authority. Gas companies should be considered to have no special claim whatever in consideration of the monopoly they had hitherto enjoyed.

SUBMARINE CABLES TRUST.

The eleventh ordinary annual meeting of the certificate holders in this Trust was held on the 9th inst. at the offices, Old Broad-street, under the presidency of J. Pender, Esq., M.P.

The SECRETARY (Mr. Lewis L. Wells) read the notice convening the meeting and the minutes of the last meeting, held on the 4th inst., which were approved by the present meeting, and signed as correct by the chairman. The report was taken as read. It has been noticed in *The Electrician*.

The CHAIRMAN then said: Before asking you to adopt the report, it may be interesting to you to hear a few remarks on it. You observe that the revenue of the Trust for the financial year ended April 15th last was £22,758, and the expenses amounted to £1,316. After paying off our coupons at the full rate of 6 per cent. we carry forward to the current year a balance of £1,837. Our property has been more or less affected by the lower tariff of the Anglo-American Company, but our investments in the Eastern and the Eastern Extension Companies have improved—and improved very considerably—since we held them first. The low tariff charged by the Anglo-American Company is very likely, I think, to be changed shortly. It has been very clearly proved that the 1s. tariff is not a success, and while they who represent those companies have been anxious to give the tariff a fair trial, I am strongly under the impression that anything less than 2s. is not a tariff that will pay the shareholders. Probably, in the course of two or three years, it might improve, as the telegraph is a progressive system; but in the meantime it would be a very heavy loss to the shareholders. I believe we shall see this remedied by and bye. In the meantime it is satisfactory to know that the value of these coupons in the market is rather improving—in fact, has considerably improved of late—and that the prospect of increasing revenue upon the stocks we hold is likely still further to improve the value of our property. It will be observed in the balance-sheet that about one-fifth of the original capital has already been cancelled by the purchase of certificates. When we have the means to purchase them we are always glad to do so; but at the same time, as the value of the property is increasing, it is still more difficult to acquire them on terms that might be considered satisfactory. At our last annual meeting we had to express regret at the serious illness of one of our auditors, and unfortunately since then Mr. Newmarch has been taken from us. I believe that the shareholders to-day will have to elect a gentleman to fill the place which Mr. Newmarch so ably occupied for some years in this Company. As you are aware Mr. Griffiths was associated with Mr. Newmarch, and I believe that during the time Mr. Griffiths has been connected with the Company he has commanded the confidence of the shareholders. I believe he will also come before you to-day for re-election. With these few remarks I will move, "That the report and the accounts now submitted be received and adopted."

Sir DANIEL GOOCH, Bart., M.P., having seconded the motion,

Mr. ASTON, Q.C., inquired if the Board thought it probable that they would be able to pay the next coupon in full, seeing the small amount coming from the Anglo-American Company.

The CHAIRMAN: I don't like to commit myself to anything. We are hopeful that we shall soon see a 2s. tariff established by the Anglo-American Company, and a great deal will depend on whether the tariff is established. If so, no doubt we shall improve. I should not like to look so far ahead, and it is dangerous to prophesy. I cannot tell you what will occur six months hence. If all my wishes and desires are realised we shall get a 2s. tariff very shortly in the Anglo-American Company, and if so we shall be in a very much better position. The motion was then submitted, and carried unanimously.

On the motion of Mr. ASTON, Mr. J. G. Griffiths (of the firm of Deloitte, Dever, Griffiths, and Co.), was re-elected an auditor of the Company. For the vacancy in the audit caused by the death of Mr. Newmarch two candidates were proposed—Mr. Aston by Mr. Batten and Mr. Gane by Mr. Donaldson, and a show of hands was in favour of Mr. Gane, whom the chairman declared elected.

Mr. ASTON then moved, and Mr. BATTEN seconded, a vote of thanks to the chairman and directors, and the motion was carried unanimously.

The CHAIRMAN: We are very much obliged to you, and very particularly obliged to Mr. Aston for kindly proposing a vote of thanks to us. I am quite sure we are anxious to do everything in our power to promote the interests of this Trust; and we are equally anxious that such elections as those of to-day should be in the hands of the shareholders. No influence in the matter has, therefore, been exercised by the directors in the election, and if Mr. Gane were to come into the room now I should not know him. I have, however, a strong personal regard for Mr. Griffiths, who has been so long connected with this Company.

The meeting then separated.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).

The tenth ordinary general of the members of this Company was held on the 10th inst. at the City Terminus Hotel, under the presidency of Mr. C. W. Earle.

The ACTING-SECRETARY (Mr. J. L. Quick), read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting. The report of the directors was taken as read.

The CHAIRMAN then said: While meeting here for the discussion of our affairs to-day there is a meeting going on on the other side of the world which may have a very marked effect on our eventual prosperity. I need hardly say that I allude to the Conference which we announce in this report as about to be held. That Conference assembled at Barbadoes on the 1st of this month. It is attended by delegates from all the British colonies interested in telegraphic connection, with the exception of Jamaica. The meeting of this Conference is the outcome of Mr. Grosvenor's mission of some fifteen months ago and the representations of the Board through him to the colonies for a revisal of the contracts. We have been lucky enough to secure the services on this occasion of Mr. Kingsford, who, as some of you may remember, conducted a very successful mission to the West Indies some six years ago, when we induced the colonies to assent to a revision of the rates for messages. It will be his duty to show the colonies that the conditions and terms accepted in the original contracts at the inception of this Company are not such as to make it possible for us to attain to the fair position of commercial prosperity which is not only the implied condition of our establishment but also the very reason for our existence, and without which it is impossible for us to continue permanently to give that constant and effectual communication which the colonies expected in making these contracts. I think on this occasion the fewer the remarks we make on the subject now being deliberated on in the West Indies the better. We can only trust that reasonable, and indeed liberal views will be taken of our position, and that a revision of some of the contracts entered into by the Company through exaggerated estimates of the traffic derivable from those regions will be granted. With regard to the action of France, in asking their Chamber to give us some assistance from their Home Government, they have not unnaturally deferred their action till they see what the British colonies will do. They said that the British Government and colonies were more interested than they, and that they would, therefore, wait to see what the British colonies decided on before they took measures to assist the Company. Upon our accounts I have very little to say. It is very satisfactory to see that there is an improvement over the corresponding period of last year of £18,000. We expended £9,000 less than then, and have received £9,000 more, making the balance of £18,000 improvement. The cables have been very fairly at work throughout the half year under report. We have had only one very serious interruption affecting the traffic—in the Demerara cable, a cable which is different in the circumstances in which it was laid and in which it operates from all the other cables belonging to our system, for its bed is a very deep bed of alluvial soil, washed down by the great Oreneko and Essequibo rivers. All the other cables that we have suffer from the rocky nature of their beds. This cable, however, lies in this deep mud, and when anything does happen to it it is very difficult to repair on account of the depth into which it sinks through the soft soil. That is a difficulty we find with that cable, which creates considerable delay in its repairs. I do not think I have any further remarks to make, but I shall be very glad to answer any question or reply to any remark you may favour me with. He then moved the adoption of the report and accounts to the 31st of December last, and the payment of 6s. a share on account of arrears of dividends on the first preference shares.

Mr. WILLIAM FORD seconded the motion, which was at once carried unanimously.

The Chairman's re-election being the next motion, Mr. Earle vacated the chair, which was taken by

Sir JAMES ANDERSON, who, in proposing the reappointment of Mr. Earle, observed that it was only fair to state that a more assiduous chairman of directors could not be found in all London. Mr. Earle had a special aptitude for and liked the work, and he left no stone unturned in any direction to further the interests of the Company committed to his care.

Mr. WM. ANDREWS seconded the motion, which was supported by

Mr. GRIFFITH, who remarked that the success of the Company depended to a great extent on the officers, and they were fortunate in having a gentleman who was so greatly interested in the work as their chairman. The unanimity with which the report had been adopted, he thought, spoke volumes for the Board. The critics had been unable to find any spot to lay their hands on. He only hoped that the success which now appeared returning to them might continue. He would make only one suggestion—that the chairman should do his utmost to keep down the expenses of the ships, which seemed very large. He would also throw out the suggestion that the Colonial Secretary might be communicated with in Downing-street, and asked to assist in inducing their friends in the West Indies to take a broader view of the position of the Company.—The motion was carried unanimously.

The CHAIRMAN acknowledged his re-election, but wished to correct one remark which Mr. Griffith had made—that he had been connected with the Company from the commencement.

Mr. GRIFFITH: No, from its resuscitation.

The CHAIRMAN, after observing that he always disclaimed being connected with the Company from the outset, moved the re-election of Mr. Ford, than whom, he stated, they could not have a more active, able, and efficient director.

Mr. ROBINSON KENDAL, in seconding the motion, expressed his belief that the Board of the Company was of an exceptional character, and one of the best in the city of London. He believed that Mr. Ford was a very active member of the Board, and took a great interest in the Company, and he was sure that the Board had done everything they could to improve the position of the concern. He only hoped that their efforts to increase the receipts of the Company would be successful, and that at the next meeting they would be able to make the announcement, as the result of the conference at the West Indies, that increased subsidies had been granted to

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them, giving the shareholders greater hopes of the future of the undertaking. The motion was then carried unanimously.

Mr. FORD expressed his thanks, and said he thought he should best show his gratitude, in their interests, by preserving the discreet silence which had been observed by the shareholders with regard to the conference. It had been his intention to address them at some little length on the past history of the Company, and give them his views as to its future prosperity. He, however, thought it would be injudicious to do so, for the reasons stated.

Mr. JOHN GEORGE GRIFFITHS having been re-appointed to his position as auditor of the Company,

The CHAIRMAN said: That concludes our formal business, but before breaking up I wish to make one remark on what Mr. Griffiths said as to urging our claims on the Colonial Minister. We have done so over and over again, but there is very great delicacy always at the Colonial Office in their action as to financial matters in connection with the colonies. I think if we made such an appeal it would almost defeat its own object, and that the colonies might resent such action on the part of the Colonial Secretary, if he took it. We have put every conceivable argument before the Colonial Secretary.

Mr. GRIFFITH agreed that any official communication from the Colonial Secretary would be resented, but he referred to private communications.

Mr. FORD stated that the directors had addressed the Colonial Secretary on two or three occasions, and had placed before him the position of the Company.

The CHAIRMAN: We have had two deputations to the Colonial Secretary.

A SHAREHOLDER expressed regret at the determination which Mr. Ford had taken to preserve silence. He was quite sure that Mr. Ford, with his usual discretion, could make a few observations on their position and prospects without clashing with the interests of the Company.

Mr. FORD, in reply, stated that if the hon. shareholder would grant him an interview after the meeting, he should be quite ready to give him reasons which would show him that it would be indiscreet to go into the position of the Company publicly.

The SHAREHOLDER expressed his satisfaction with Mr. Ford's statement, and the meeting then separated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES MAY 10.		BUSINESS DONE WEEK ENDING MAY 10. Highest.	Lowest
Anglo-American	54¼,	54¾	54¾	54
Do. Preferred	85½,	86½	86½	85½
Do. Deferred	24½,	25	24½	24½
Brazil Submarine	11,	11¼	11¼	11
Cuba	8½,	9	8¾	8½
Do. Preference	15½,	16½	—	—
Direct Spanish	5¾,	6¼	6	6
Do. Preference	14½,	15½	—	—
Direct United States Cable	11¾,	12	11 5-16	11¼
Eastern Telegraph	10,	10¼	10 5-16	10¼
Do. 6 per Cent. Preference	12½,	13	13¼	13
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11½,	11¾	11¾	11
German Union	9½,	10¼	10	9¾
Globe Telegraph and Trust Company.	6½,	6¾	6 9-16	6 7-16
Do. Preference	12½,	12¾	12¾	12¾
Great Northern	12¾,	13¼	12¾	12¾
Indo-European	30,	31	—	—
Mediterranean Extension	2,	2¼	—	—
Do. Preference	8½,	9	—	—
Reuter's	12½,	13¼	13¾	13
Submarine	260,	270	268	265
West India and Panama	1½,	2	1¾	1¾
Do. 1st Preference	8½,	9	8¾	8¾
Western Brazilian	7¾	8¼	8	7¾
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1¾	1 9-16
Oriental	¼,	½	½	½
United Telephone	15,	15½	13¾	13¾

ELECTRIC LIGHT.

Eastern Electric Light and Power	4¼,	4¾	4¾	3¾
Electric Light and Power	¾,	1¼	1¼	¾
Anglo-American Brush	18,	18½	18¾	13¾

TRAFFIC RECEIPTS FOR APRIL, 1882.

COMPANIES.	April, 1882.	April, 1881.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,600	3,193	607	—
Direct Spanish Telegraph Company	1,824	1,337	487	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	29,269	26,746	2,523	—
Eastern Telegraph Company	42,667	45,289	—	2,622
Great Northern Telegraph Company	17,640	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

ADDRESSES.

M. THEILER & SONS, Manufacturing Electricians,
86, CANONBURY ROAD, LONDON, N. Factory: 1, Alwyne-lane, N.
Specialities—Morse Instruments, Type Printers, Cable Relays and Keys, DUPLEX, Quadruplex, & Translating Apparatus, P.O. Pattern. MAGNETO BELLS and SWITCH BOARDS of superior construction. Gold Medal, Melbourne, 1880; Silver Medal, Paris, 1881.

TAYLOR and Co., Mica Merchants, 90, HATTON GARDEN, LONDON.

RANSOMES, HEAD, & JEFFERIES, Orwell Works,
IPSWICH. London Office: No. 9, GRACECHURCH-STREET, E.C.
Specialities—Portable, Vertical, and Stationary Engines, fitted with patent governors, as used in the electric lighting on the Thames Embankment, London, &c.

EDWARD PATERSON, Electrical and Telegraph
Engineer, 76, LITTLE BRITAIN, LONDON, E.C., and European Telegraph Works, POWNALL-ROAD, DALSTON.
Telephones and Transmitters, and all Fittings for Central Exchange Systems and Private Lines. Ayrton and Perry's Instruments for Electric Light Measurements. Electric Lighting Apparatus, Cables, &c. House and Mine Signals.

PHILLIPS BROS., Electricians and Electrical Wire
Manufacturers, MACINTOSH-LANE, HOMERTON, LONDON.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c.

MARSHALL, SONS, and Co., Limited, Britannia
Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

BRITISH ELECTRIC LIGHT COMPANY (Limited),
HEDDON-STREET, REGENT-STREET, LONDON, W.
Gold Medal at the Paris Electrical Exhibition, 1881.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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WORKS, MITCHAM and MILLWALL DOCKS.
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BLOOMSBURY, LONDON. Works: MORWELL STREET, BEDFORD SQUARE.
Electric Bells, Fire and Thief Alarms, Water Gauges, Watchmen' Clocks, Telephones and Transmitters. Lines Erected and Maintained. Lightning Conductors. Electric Light Apparatus supplied and fixed. Prize Medal, London, 1862; First Prize, Sydney, 1879; Prize Medal, Melbourne 1880; Prize Medal, Paris, 1881.

W. T. GLOVER and Co., Insulated Wire Manu-
facturers, 25, BOOTH-STREET, MANCHESTER. Works: Salford.
Specialities—Specially covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron Wire for Aerial Lines. Fancy covered Copper Wire (Paraffined) for Telephonic and Bell purposes. Cotton covered G.P. Wire for Bell Work. Special Makes of Electric Light Leads for the Brush, Gramme, &c., systems.
All classes of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post-office and the principal Railway and Telephone Companies.

BARRAUD and LUNDS, 41, Cornhill, London, E.C.
Inventors, Patentees, and Manufacturers of Synchronised Clocks, Time Balls, Flashing Signals, and all the Apparatus connected with the Determination, Distribution, and Control of Time Signals.

THE LONDON ELECTRIC WIRE COMPANY,
WENLOCK BUILDINGS, IRONMONGER ROW, OLD STREET LONDON, E.C.
Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

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Manufacturers of Porous Cells, Cylinders, Plates, Telegraph Insulators, Battery Jars, Chemical Apparatus, &c., in Vitrified Stoneware, Plumbago Crucibles.
Prize Medal for above Paris Electrical Exhibition, 1881.

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